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November 1995

GENCORP
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METSAT

**Advanced Microwave Sounding Unit-A2 (AMSU-A2)
Structural Mathematical Model**

**Contract No: NAS 5-32314
CDRL: 102b**

Submitted to:

**National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771**

Submitted by:

**Aerojet
1100 West Hollyvale Street
Azusa, California 91702**

N96-15734

Unclass

G3/35 0083087

(NASA-CR-199757) METSAT: ADVANCED
MICROWAVE SOUNDING UNIT-A2
(AMSU-A2) STRUCTURAL MATHEMATICAL
MODEL Final Report
(Aerojet-General Corp.) 106 p

Aerojet

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Section 1

INTRODUCTION

1.1 Identification

This is the Structural Mathematical model for the AMSU-A2 unit to be used in the METSAT/Advanced Microwave Sounding Unit-A (AMSU-A) instrument. This document is submitted in response to contract NAS 5-32314, CDRL 102B.

1.2 Scope

This document provides the METSAT/AMSU-A2 unit structural mathematical model.

1.3 Purpose and Objectives

The purpose of the Structural Mathematical model is to verify the structural adequacy of the AMSU-A2 instrument for loading environments specified in the PAR, GSFC S-480-79.

The model can also be used by the spacecraft contractor for coupled loads analysis.

1.4 Document Status and Schedule

This is the final submittal of the METSAT/AMSU-A Structural Mathematical model.

Section 2

RELATED DOCUMENTATION

2.1 Parent Documents

None.

2.2 Applicable Documents

The following documents are referenced or applicable to this report. Unless otherwise specified, the latest issue is in effect.

National Aeronautics and Space Administration

GSFC S-480-79

EOS/METSAT Program Performance Assurance
Requirements for General Instruments

GenCorp Aerojet

Report 10390

Earth Observing System (EOS) Advanced
Microwave Sounding Unit-A (AMSU-A) Structural
Mathematical Model, AMSU-A2 Unit

2.3 Information Documents

None.

Section 3

STRUCTURAL MATH MODEL

3.1 Model Description

The MSC/NASTRAN model of the METSAT/AMSU-A2 Instrument consists of the various compliant and rigid elements that represent the structural and non-structural parts of the instrument. The parasitic mass, which represents miscellaneous items such as wiring, LP filters, coax, waveguide, mounting hardware and switches, was distributed throughout the model by increasing the mass density of the aluminum material used to model the structure. The model statistics are as follows:

<u>Element Type</u>	<u>Number in Model</u>
CBEAM	4
CBAR	274
CELAS1	23
CONM2	99
CQUAD4	2661
CTRIA3	429
Grid Points	3164

Plots of all elements in the model are contained in Appendix A. Figures A-1 through A-12 show the complete model and areas of major changes in the model since the submittal of reference (b). The model includes a refine momentum compensator, the machined baseplate, an updated Signal Processing Assembly (card cage) and the additional mass of the new power control/monitor assembly. Figures A-13 through A-88 show element and grid point locations.

The concentrated mass elements, CONM2, used in the model are shown in Figures 1 through 4 and are listed in Table 1. The material properties used in model are listed in Table II. The model weight based on the above data is 107.2 pounds and the output from the grid point weight generator is summarized in Table III. The estimated weight, based on the NOAA instrument, is summarized in Table IV. The model weight is within 2.2% of the estimated weight.

The model changes made to EOS model to reflect the METSAT configuration are as follows:

1. A refine momentum compensator added
2. Machined baseplate added
3. Card cage updated
4. New power control/monitor added (lump masses)

The remodeling of the momentum compensator added 315 elements to the model and weighs 12.93 pounds. The updated card cage added 1149 elements and weighs 11.22 pounds. The machined baseplate added 609 elements and weighs 3.51 pounds. The power control/monitor assembly is model as a group of eleven CONM2 elements and the board location in the model is as shown in Figure 5.

The model is in the EOS spacecraft coordinator system and will not be reoriented, since the first fundamental structural frequency is above 100 Hz. The thirteen mounting locations, with grid point numbers, are shown in Figure 6.

Table I Concentrated Mass Elements (CONM2)

CONM2	Grid Point	Item	Weight (lb)
2201	2201	Isolator	0.3
2202-2204	2660, 2648	Warm Load and	
2210	2650, 2658	DC/DC Converter	12.952
2402	2204	Feed Horn	0.89
2403	2202	Filters	1.656
2405	2200	Diplexer WG and Mix	0.24
2406	2205	I.F. Amplifiers Cabling and Coax	0.44
2407	2206	Gunn Osc. #1	2.5
2408	2196	Gunn Osc. #2	2.5
2409	1890	Resolver Rotor	0.28
2413	2197	Detector/PRF-Amp	0.85
1414	3053	Secondary Reflector	0.452
4200	1885	Clamp	0.12
4201	1886	Bearing	0.12
4202	1887	Bearing	0.12
4208	1888	Motor Rotor/Hub	2.2
4209-4216	3037-3044	Resolver Stator	0.96
21805-21811		Circuit Boards, Signal Processing Assy	6.742
21813-21816			
21820-21827			
21829-21833			
23188-23199		Compensator Stator	2.425
23220-23221		Compensator Bearing	0.50
23423-23446		Compensator Rotor	2.957

Table II AMSU-A2 Model Material Properties

Material ID	Material Type	Location Used	E (psi)	μ	W (lb/in ³)
1	Beryllium	RF Shelf	42.5×10^6	0.02	0.067
2	Graphite/Epoxy	Reflector	14.2×10^6	0.34	0.063
3	Steel	Motor Shaft	29×10^6	0.3	0.283
21	Aluminum	Panels and Baseplate	10×10^6	0.3	0.1
22	Aluminum	Dummy CBARs	10×10^6	0.3	—
100	Aluminum	Motor Housing	10×10^6	0.3	0.8842
103	Fiberglass	Circuit Cards	3×10^6	0.32	0.154
104	Aluminum	Panels	10×10^6	0.33	0.1

Table III METSAT AMSU-A2 Model Weight

OUTPUT FROM GRID POINT WEIGHT GENERATOR

REFERENCE POINT = 0

M O

* 1.071979E+02	1.756151E-10	-1.257703E-09	-1.772651E-10	1.201782E+03	-1.019539E+03 *
* 1.756151E-10	1.071979E+02	6.216528E-10	-1.201782E+03	-3.024719E-09	-1.544687E+02 *
* -1.257703E-09	6.216528E-10	1.071979E+02	1.019539E+03	1.544687E+02	3.201984E-09 *
* -1.772651E-10	-1.201782E+03	1.019539E+03	3.389590E+04	4.888595E+03	6.319220E+02 *
* 1.201782E+03	-3.024719E-09	1.544687E+02	4.888595E-03	2.365275E+04	-1.102023E+04 *
* -1.019539E+03	-1.544687E+02	3.201984E-09	6.319220E+07	-1.102023E+04	2.092609E+04 *

S

* 1.000000E+00	0.000000E+00	0.000000E+00 *
* 0.000000E+00	1.000000E+00	0.000000E+00 *
* 0.000000E+00	0.000000E+00	1.000000E+00

DIRECTION
MASS AXIS SYSTEM (S)

X	MASS	X-C.G.	Y-C.G.	Z-C.G.
Y	1.071979E+02	-1.653625E-12	9.510813E+00	1.121088E+01
Z	1.071979E+02	-1.440968E+00	-2.821623E-11	1.121088E+01
		-1.440968E+00	9.510813E+00	2.986985E-11

* 1.072623E+04	-3.419472E+03	1.099807E+03 *
* -3.419472E+03	9.957133E+03	-4.096963E+02 *
* 1.099807E+03	-4.096963E+02	1.100686E+04 *

I(Q)

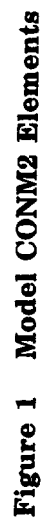
* 6.650717E+03		
*	1.389224E+04	
*		1.114726E+04 *

Q

* -6.611958E-01	7.501737E-01	7.712791E-03 *
* 7.127952E-01	6.313906E-01	-3.053994E-01 *
* -2.339724E-01	-1.964312E-01	-9.521931E-01 *

Table IV METSAT/AMSU-A2 Estimated Weight

Description	Estimated	Actual	Total
A2 NOAA Total Weight		102.98	102.98
Honeycomb Baseplate, Remove		-2.53	-2.53
Machined Baseplate, CAD	3.4		3.4
28V Switching Power Assy. FEM	-0.7		-0.7
New Power Control/Monitor	1.6		1.6
Side Panel Modifications	0.12		0.12
Total	4.42	100.45	104.87



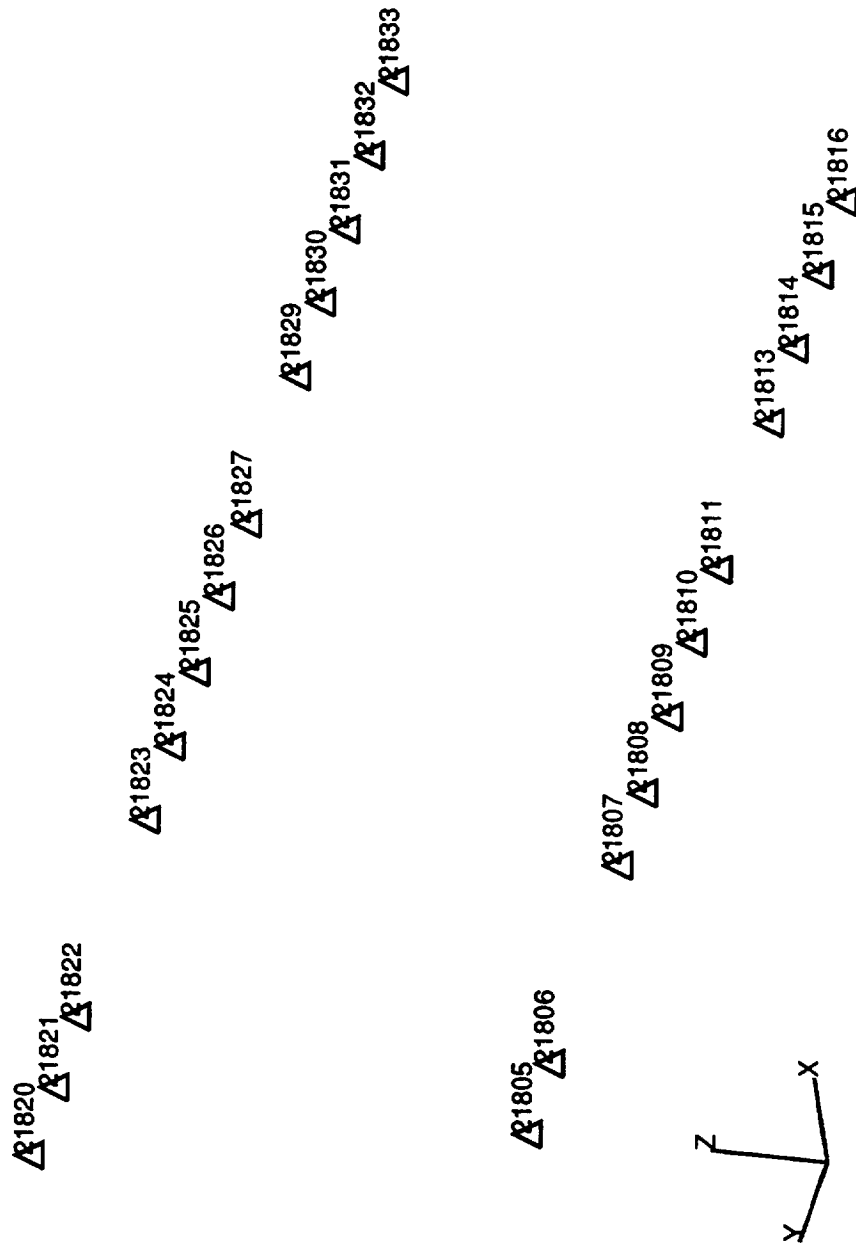


Figure 2 CONM2, Card Cage

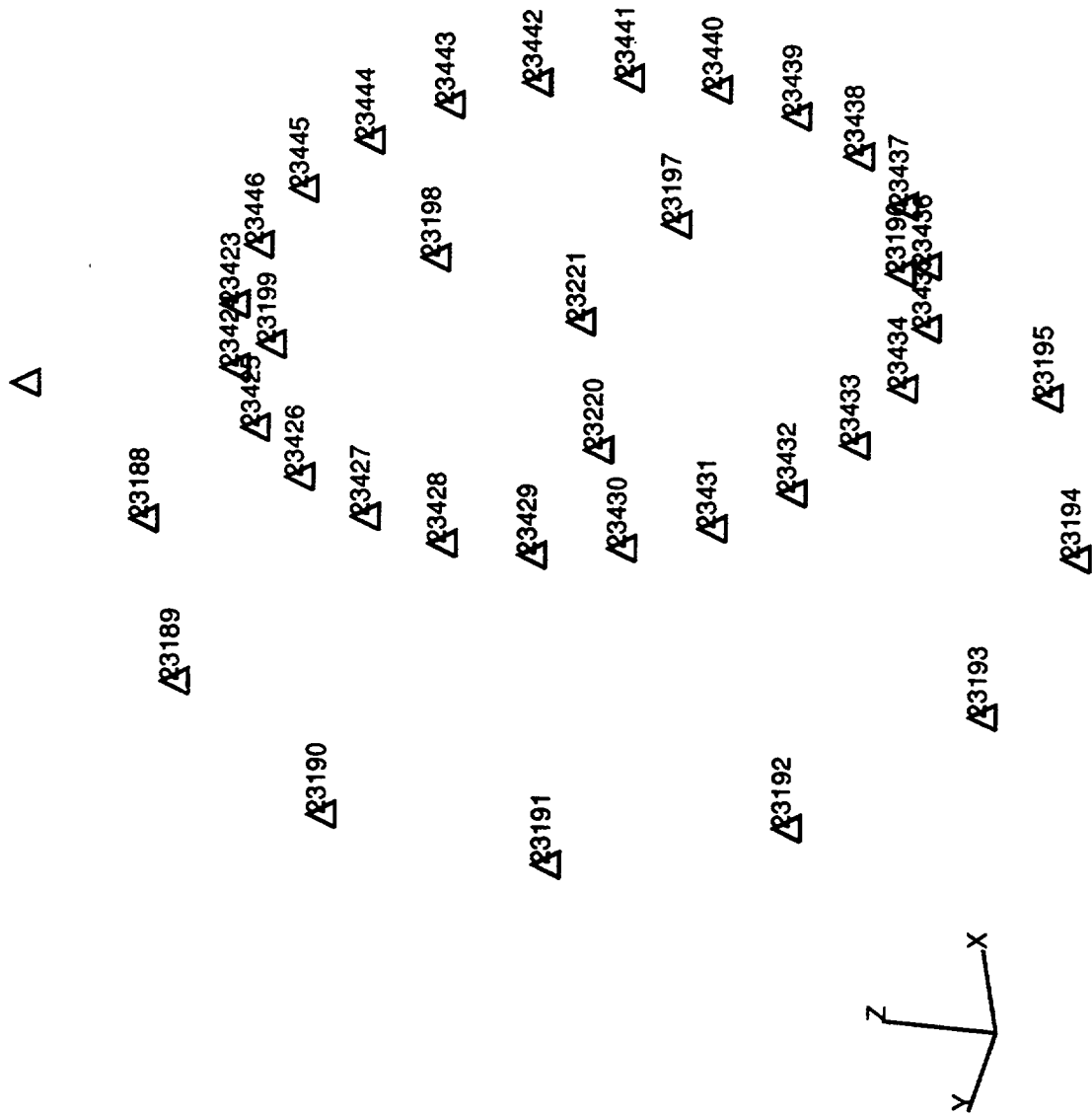
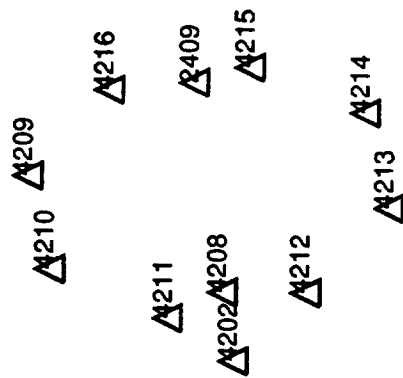


Figure 3 CONM2, Compensator



A200 A201



Figure 4 CONM2, Resolver Stator

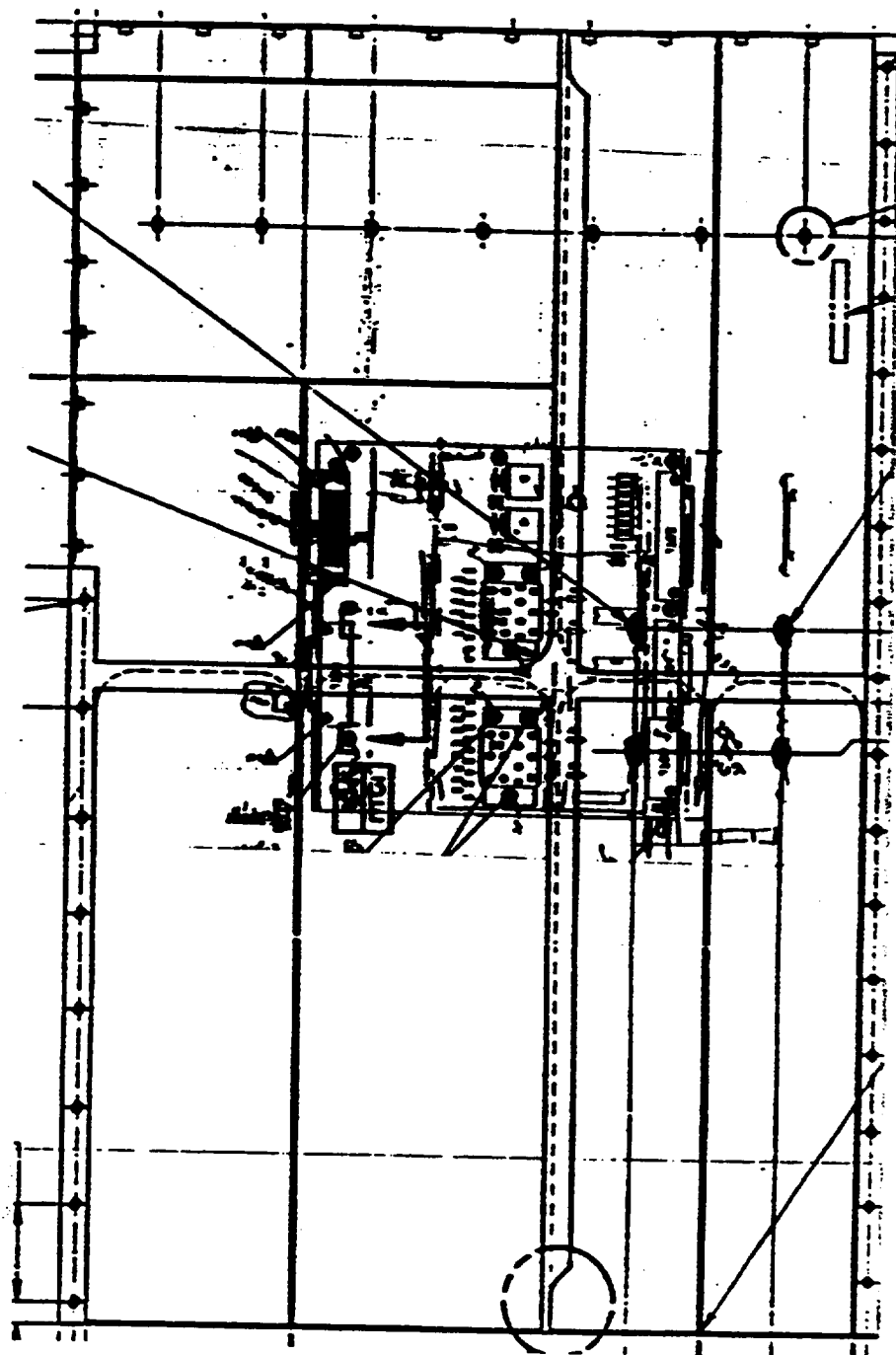


Figure 5 New Power Control/Monitor Location In Model

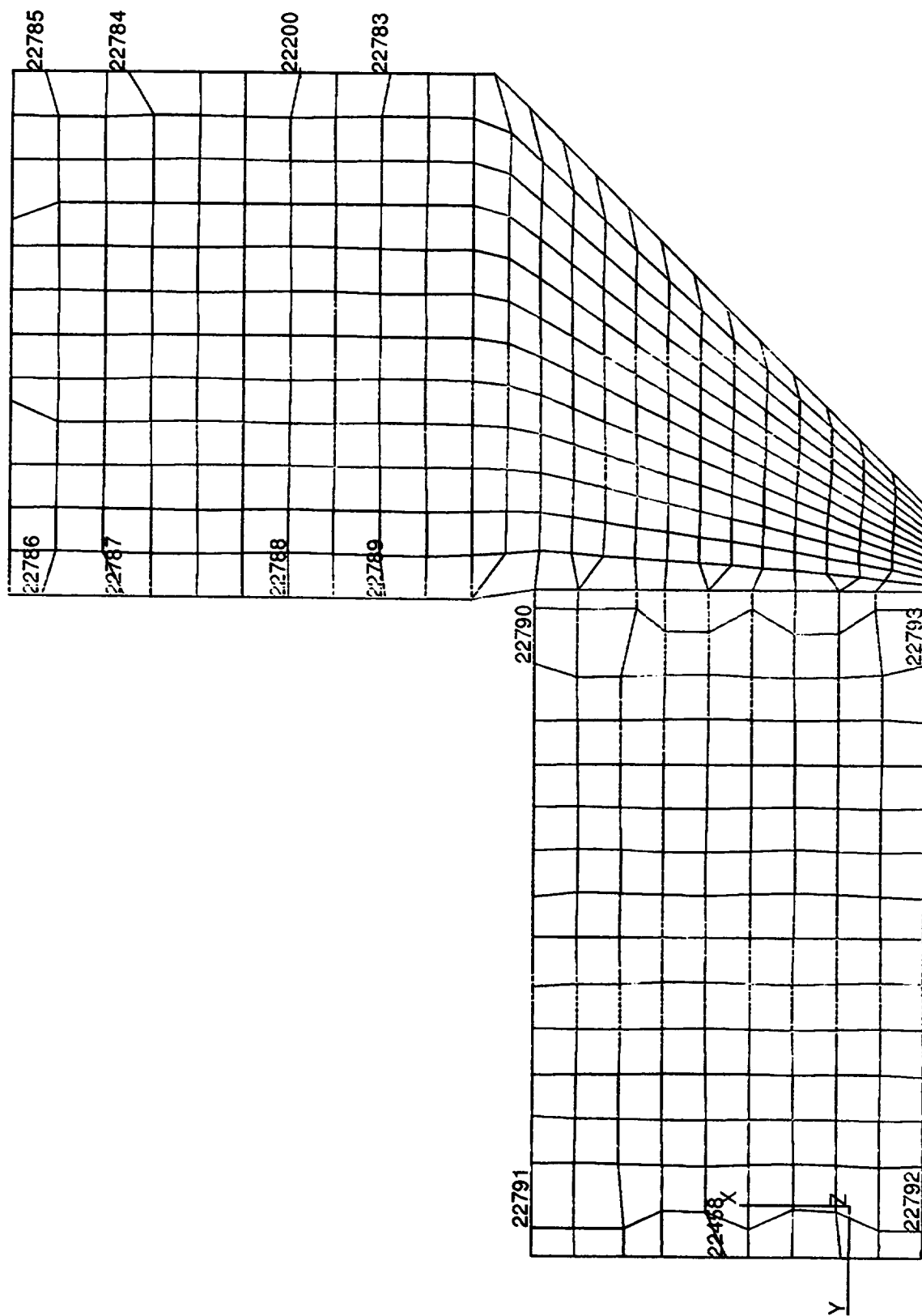


Figure 6 Baseplate Mounting Locations

Appendix A
METSAT/AMSU-A2
Finite Element Model
Element and Grid Point Plots

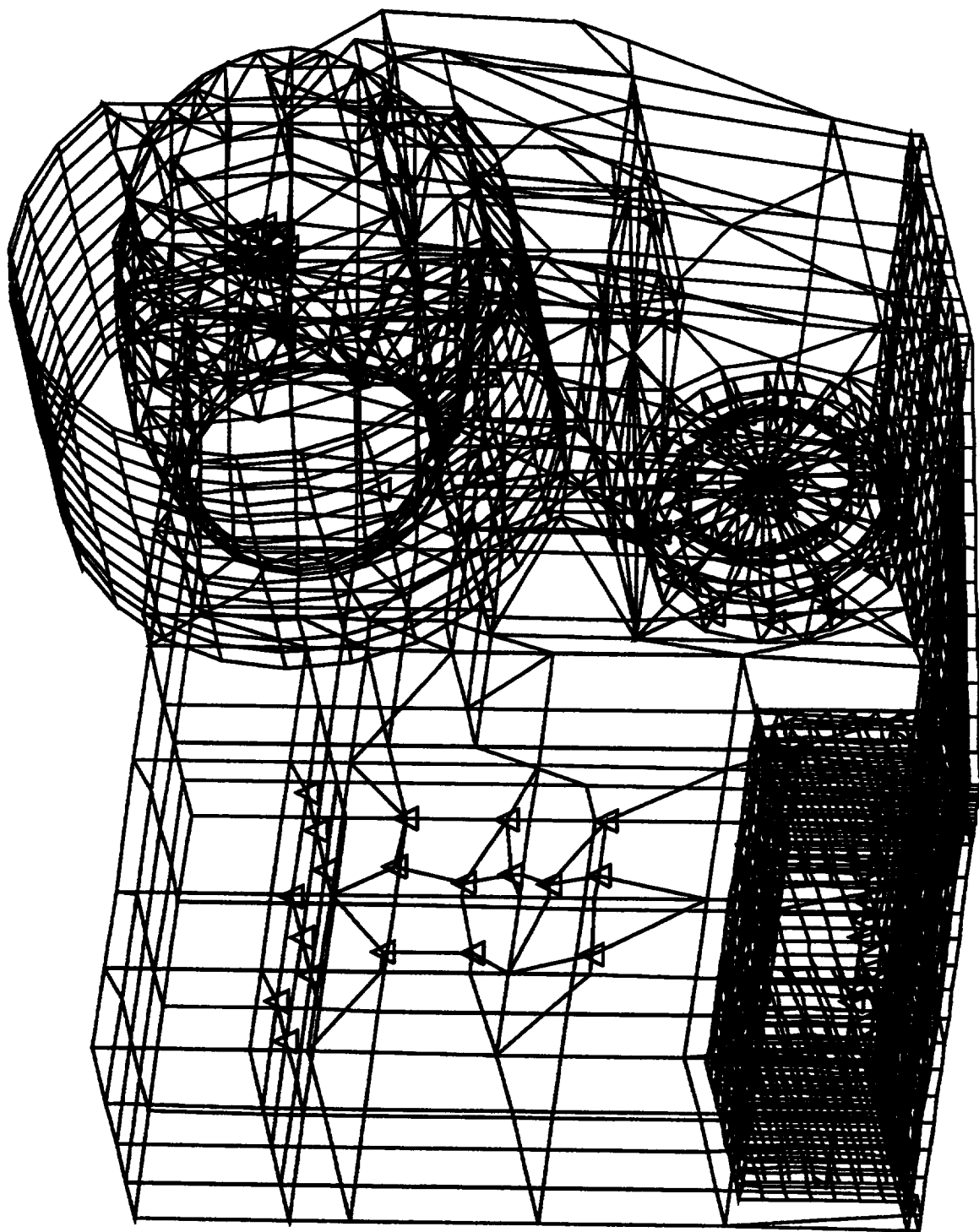


Figure A-1 METSAT/AMSU-A2 Finite Element Model Momentum Compensator Side

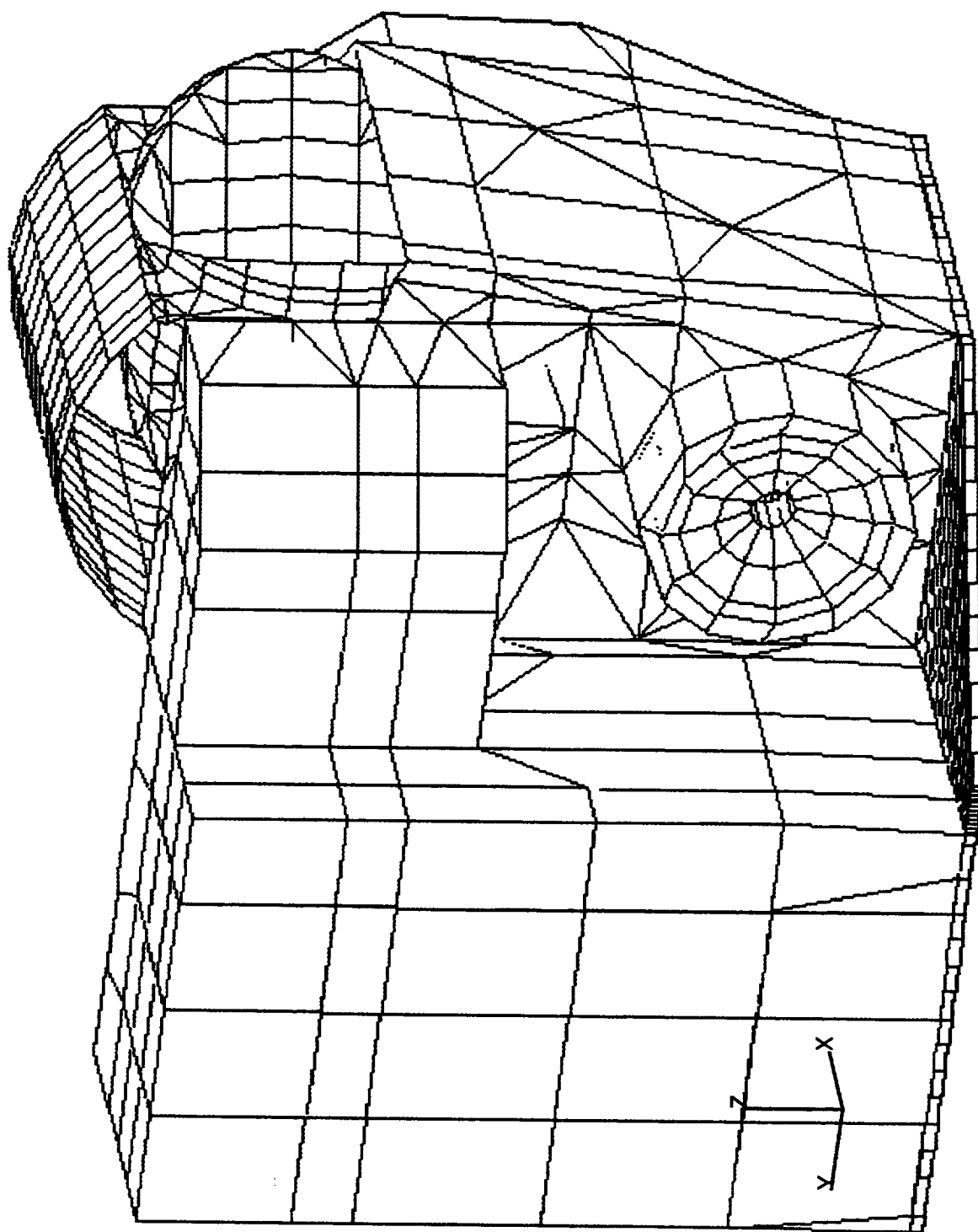


Figure A-2 Hidden Line View Momentum Compensator Side

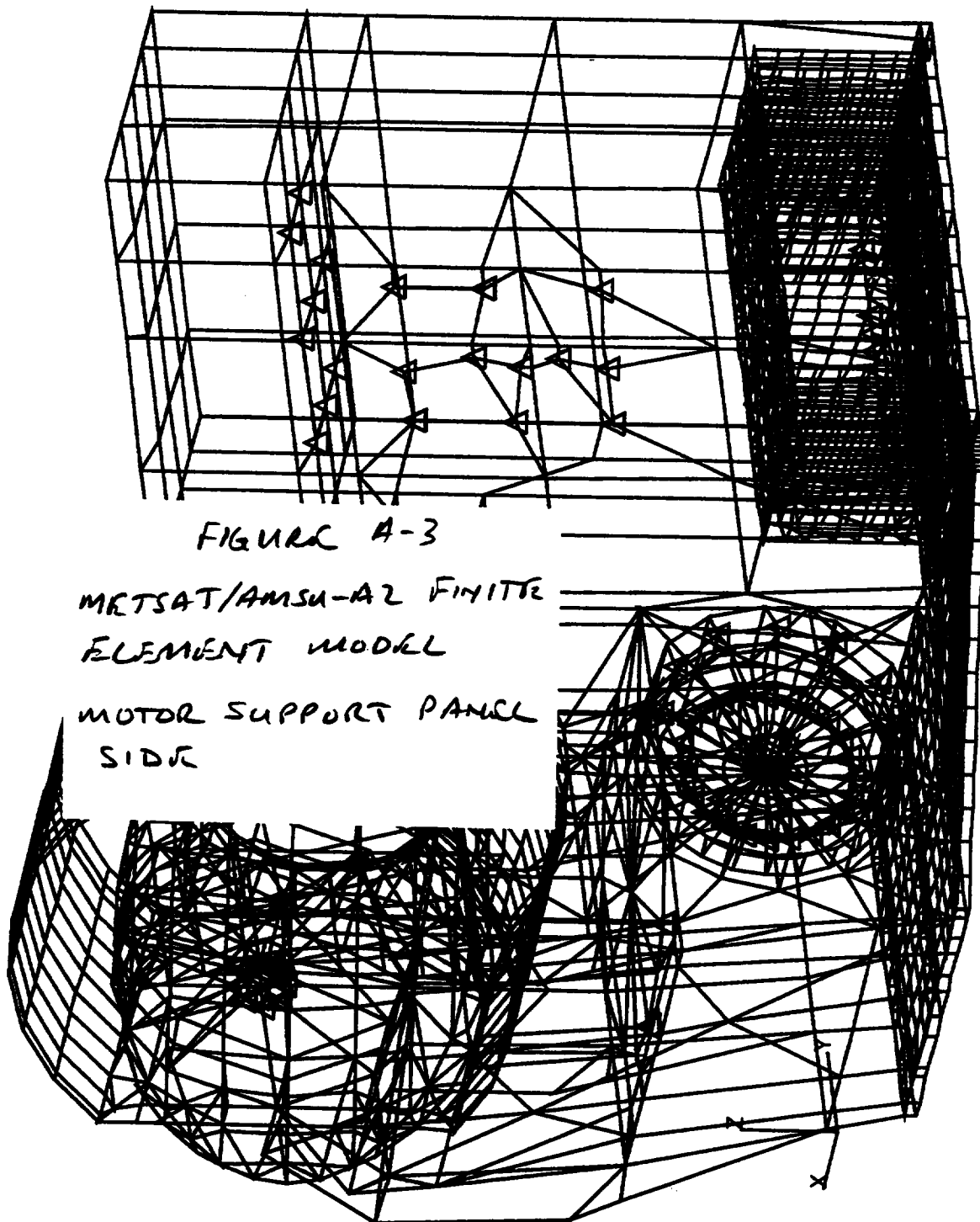


Figure A-3 METSAT/AMSU-A2 Finite Element Model Motor Support Panel Side

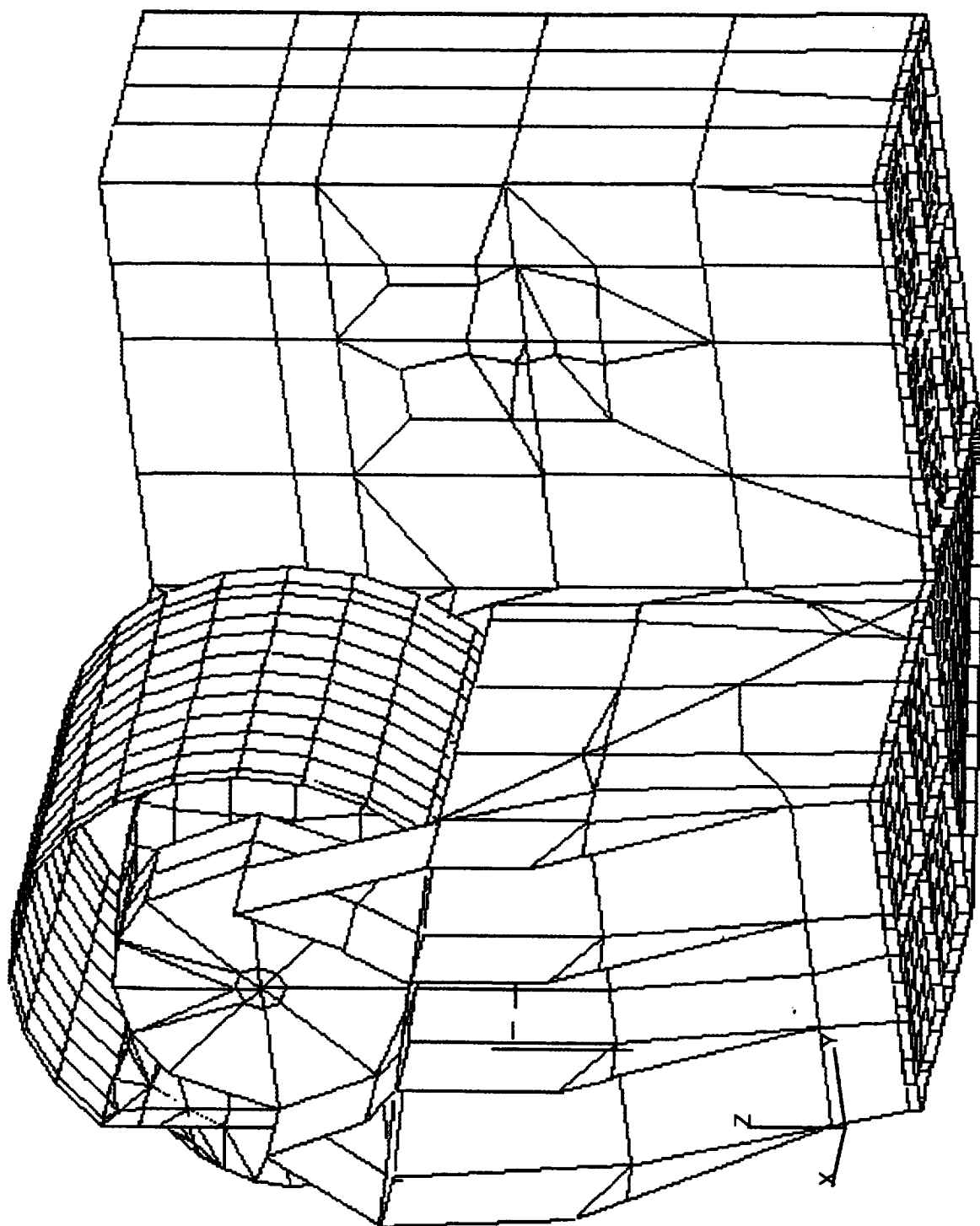


Figure A-4 Hidden Line View Motor Support Panel Side

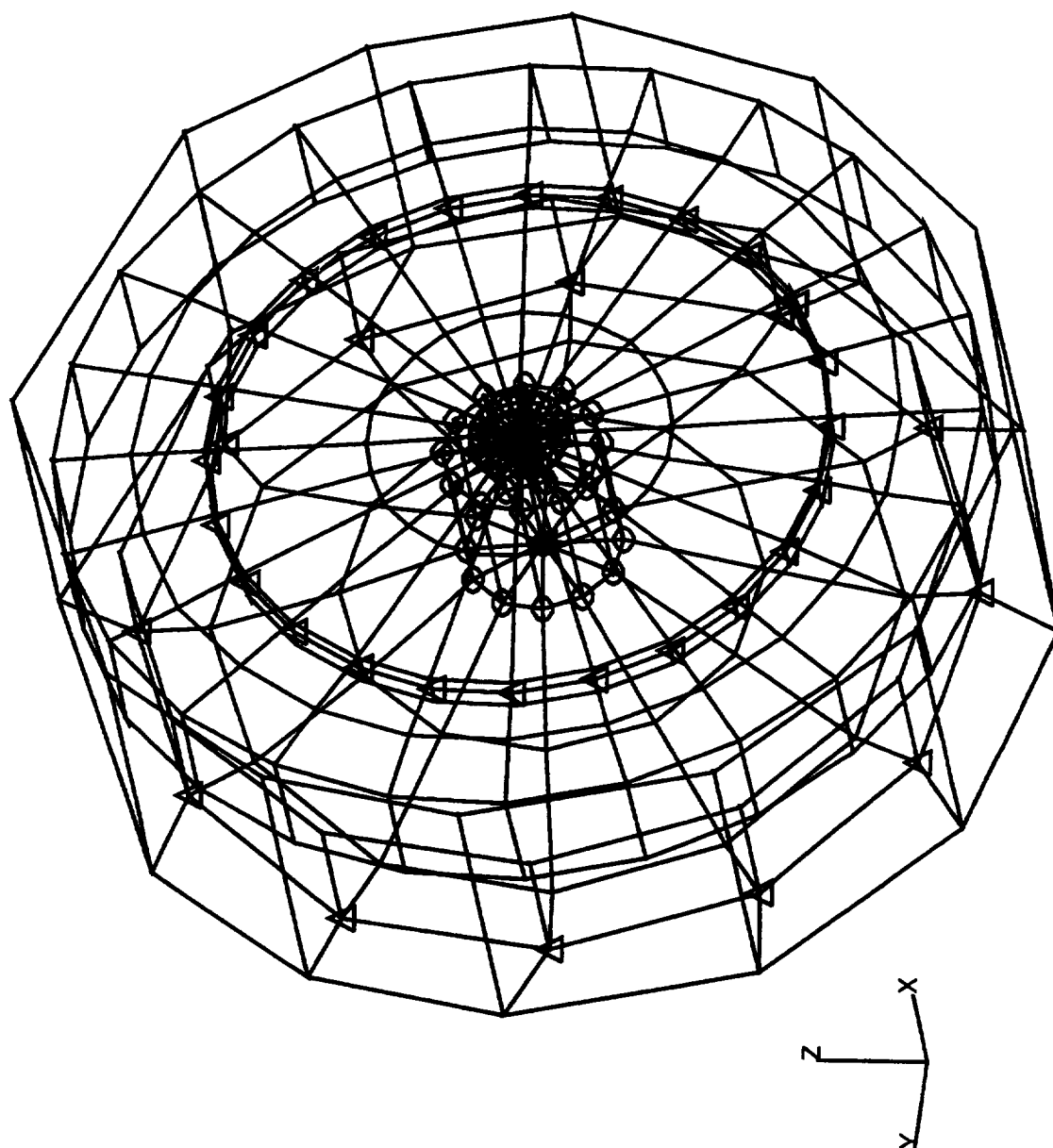


Figure A-5 Refine Momentum Compensator Model

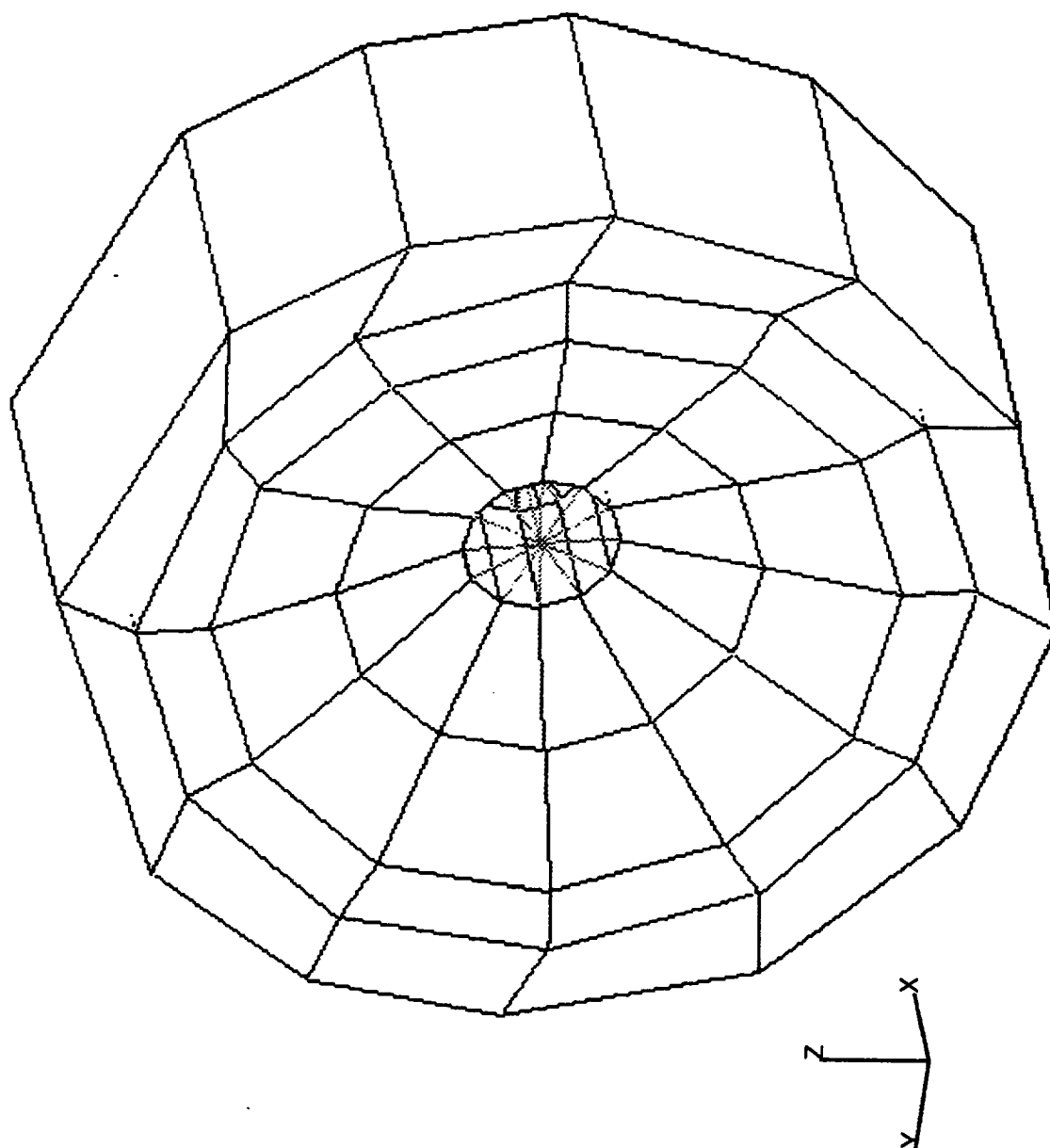


Figure A-6 Hidden Line View Momentum Compensator Housing

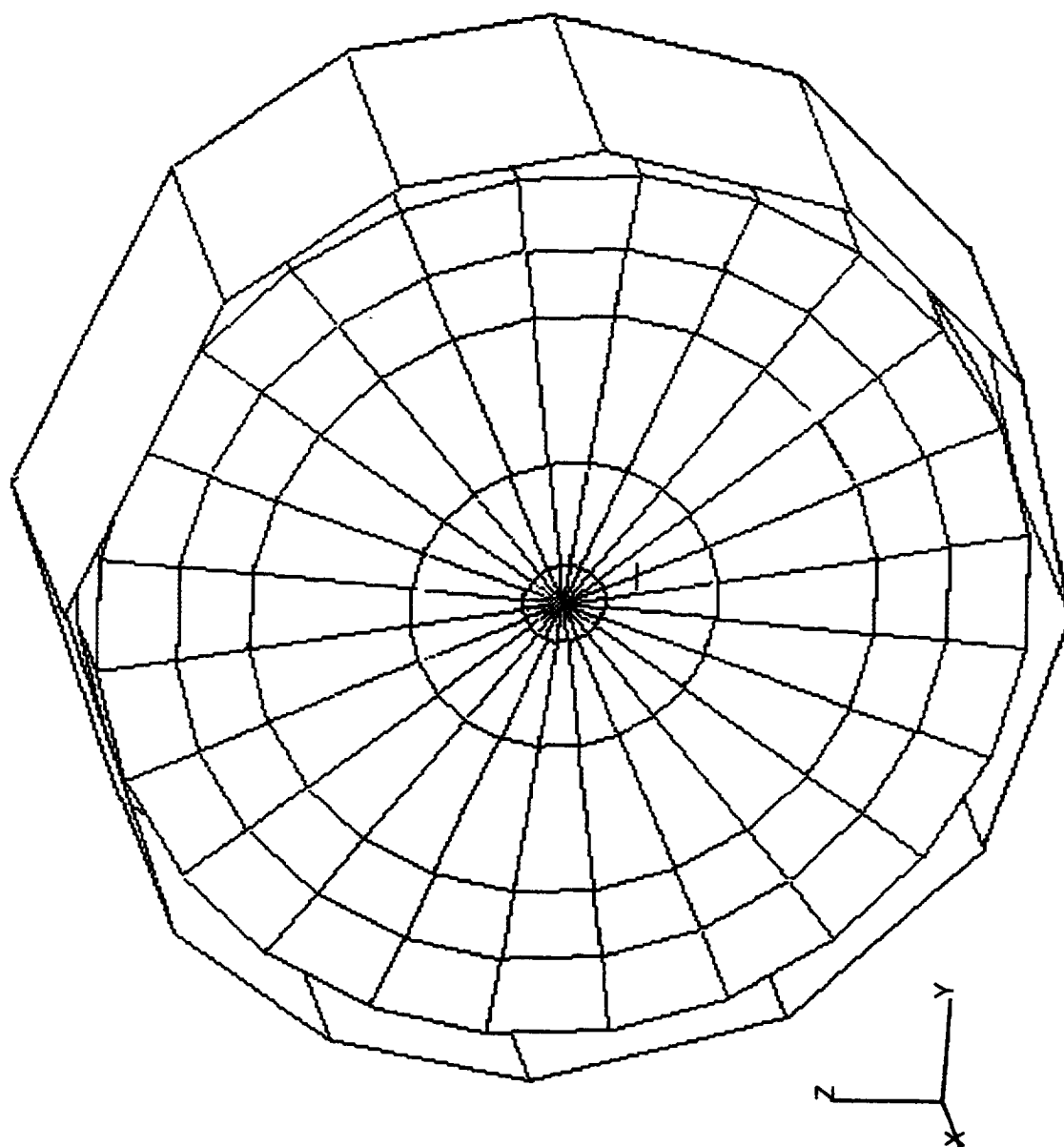


Figure A-7 Hidden Line View Momentum Compensator Rotor

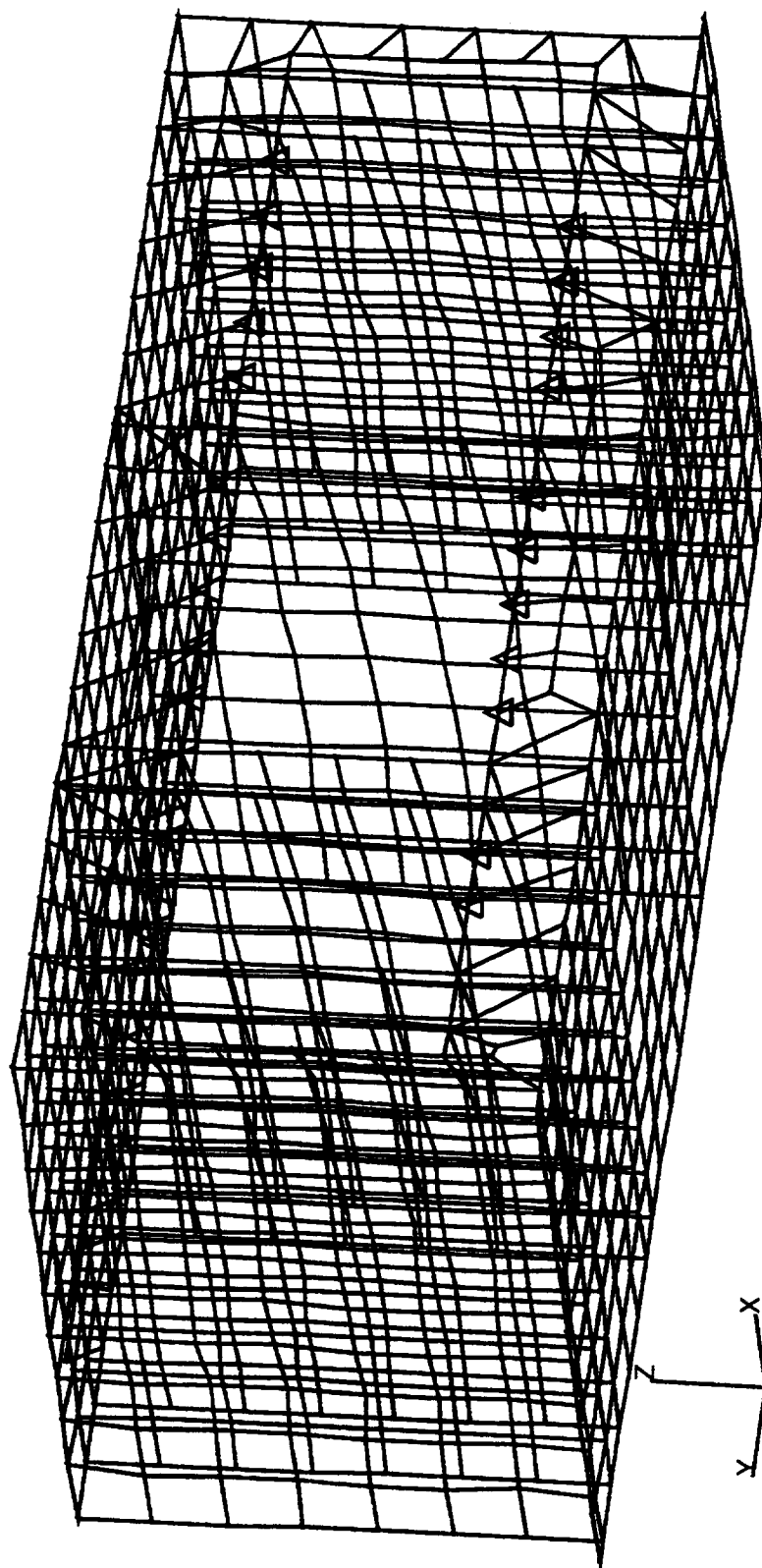


Figure A-8 Signal Processing Assembly Model

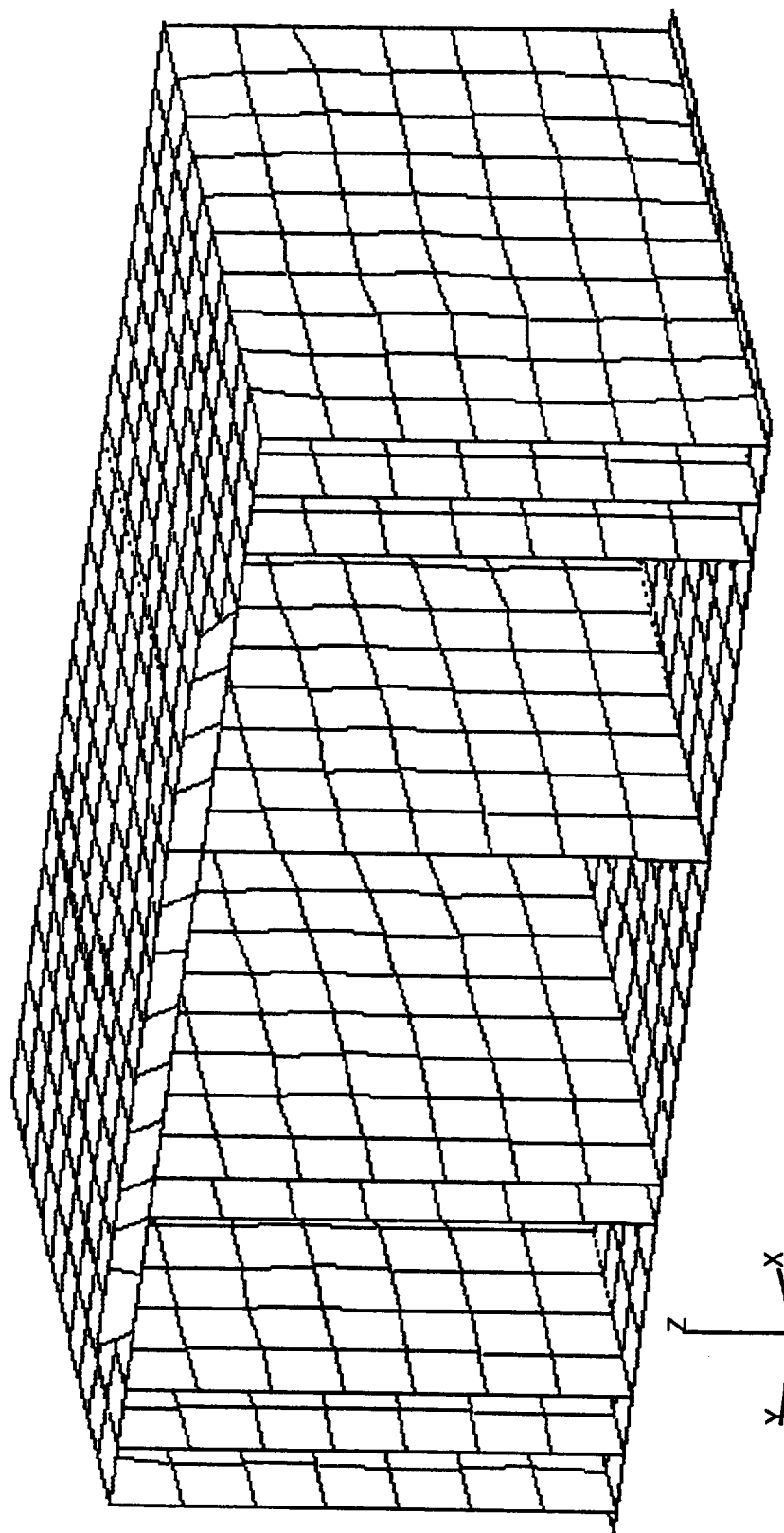


Figure A-9 Hidden Line View Circuit Card Insertion Side

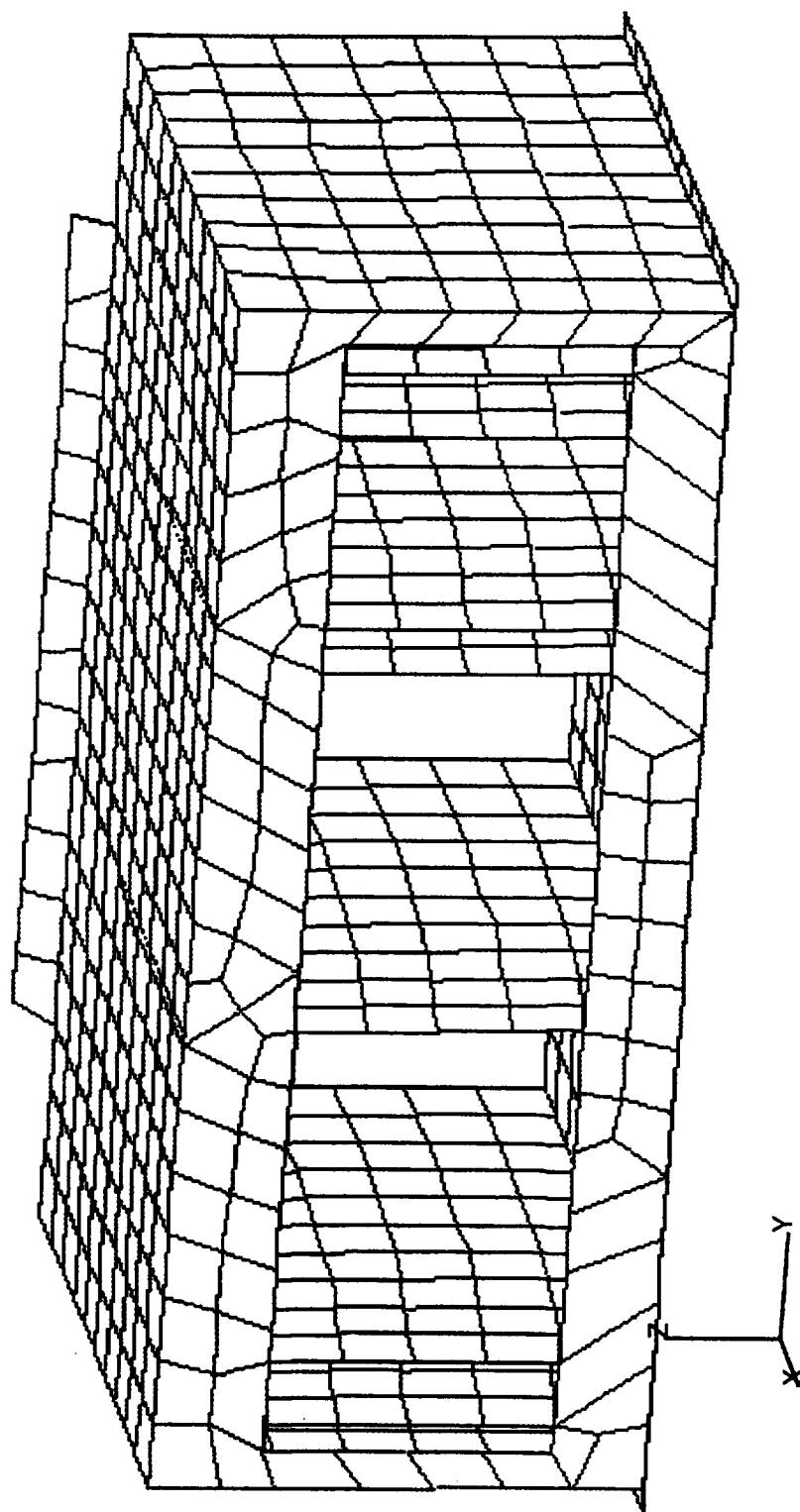


Figure A-10 Hidden Line View Circuit Card Connector Side

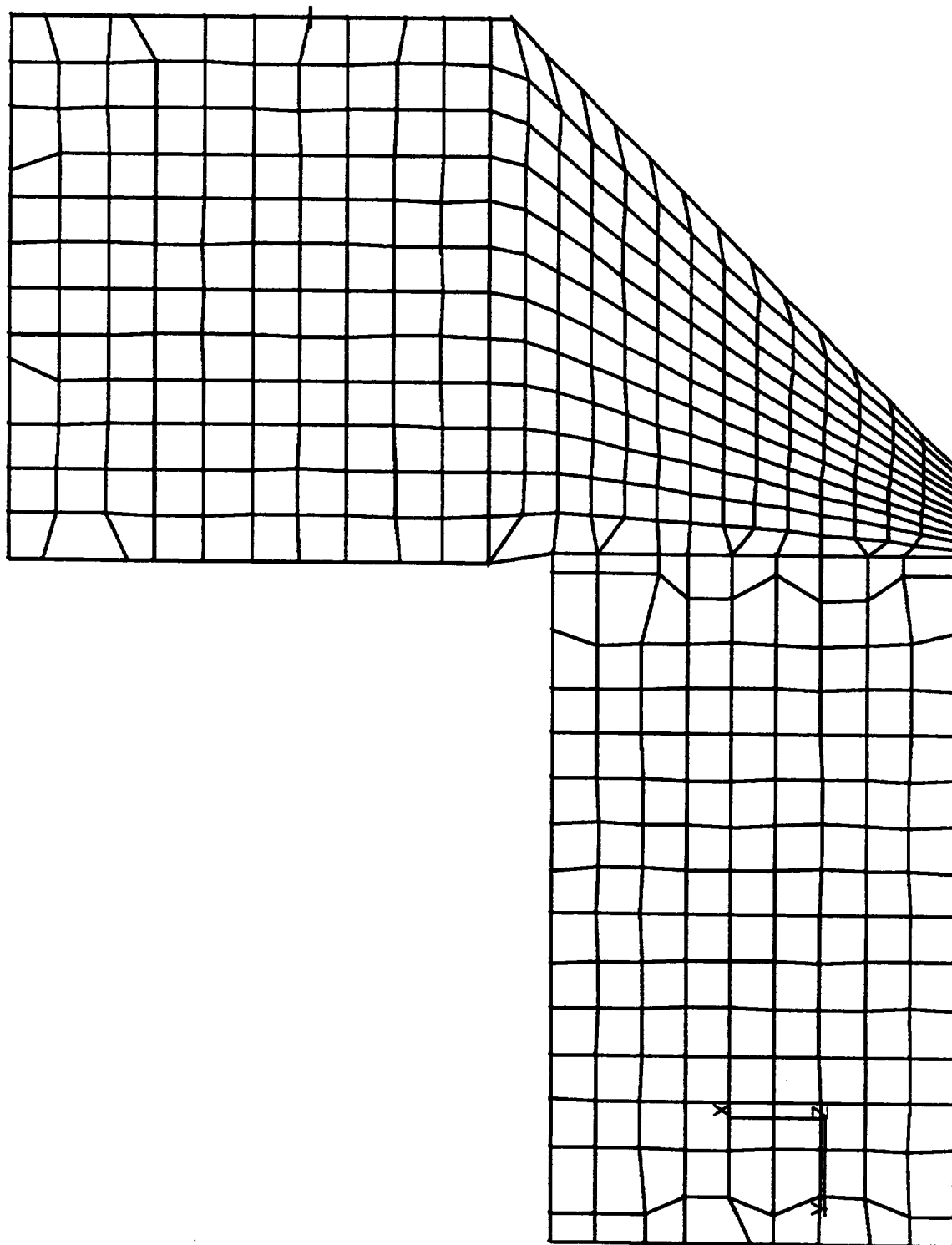


Figure A-11 Machined Baseplate

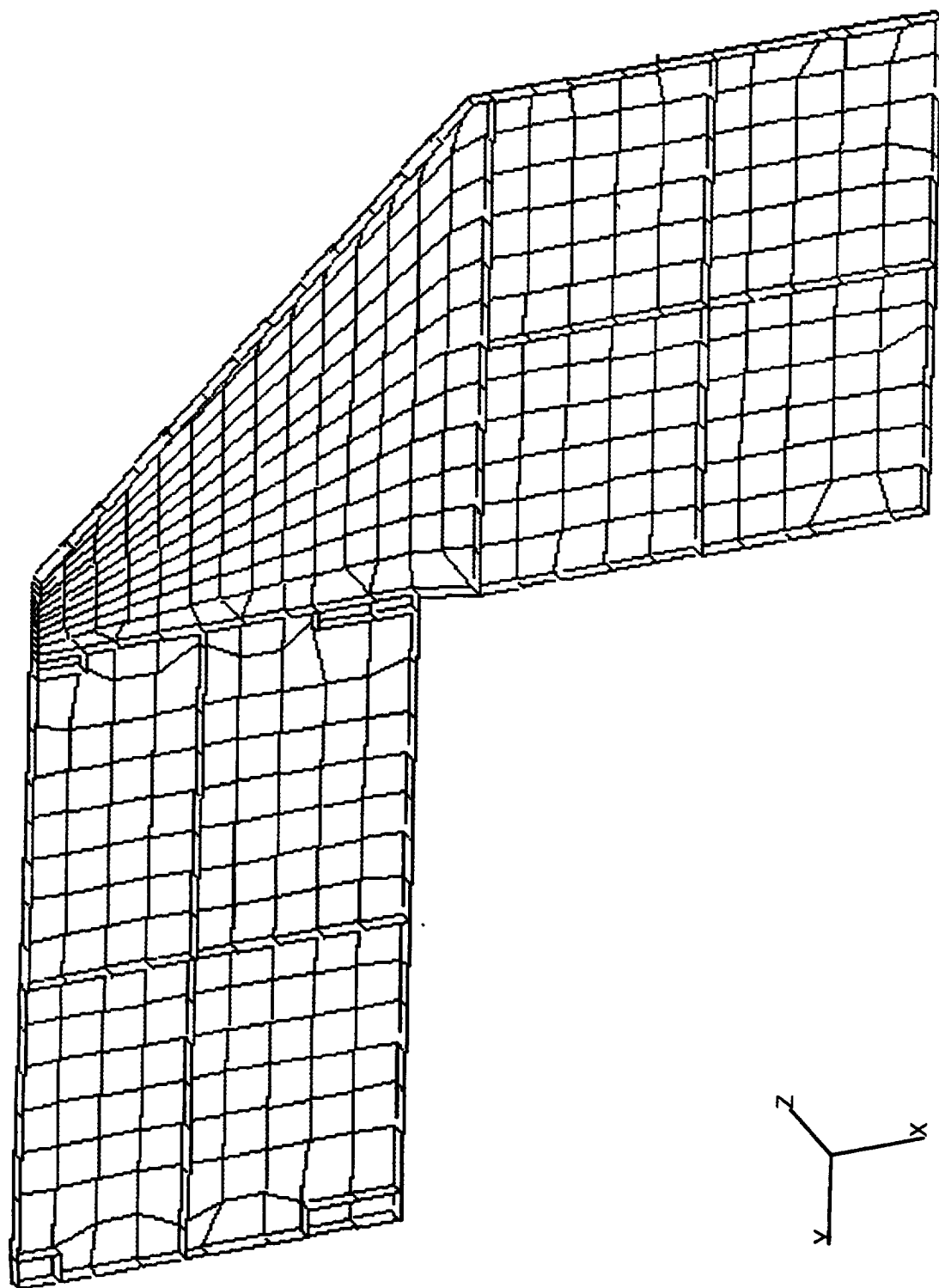


Figure A-12 Hidden Line View Bottom Surface Machined Baseplate

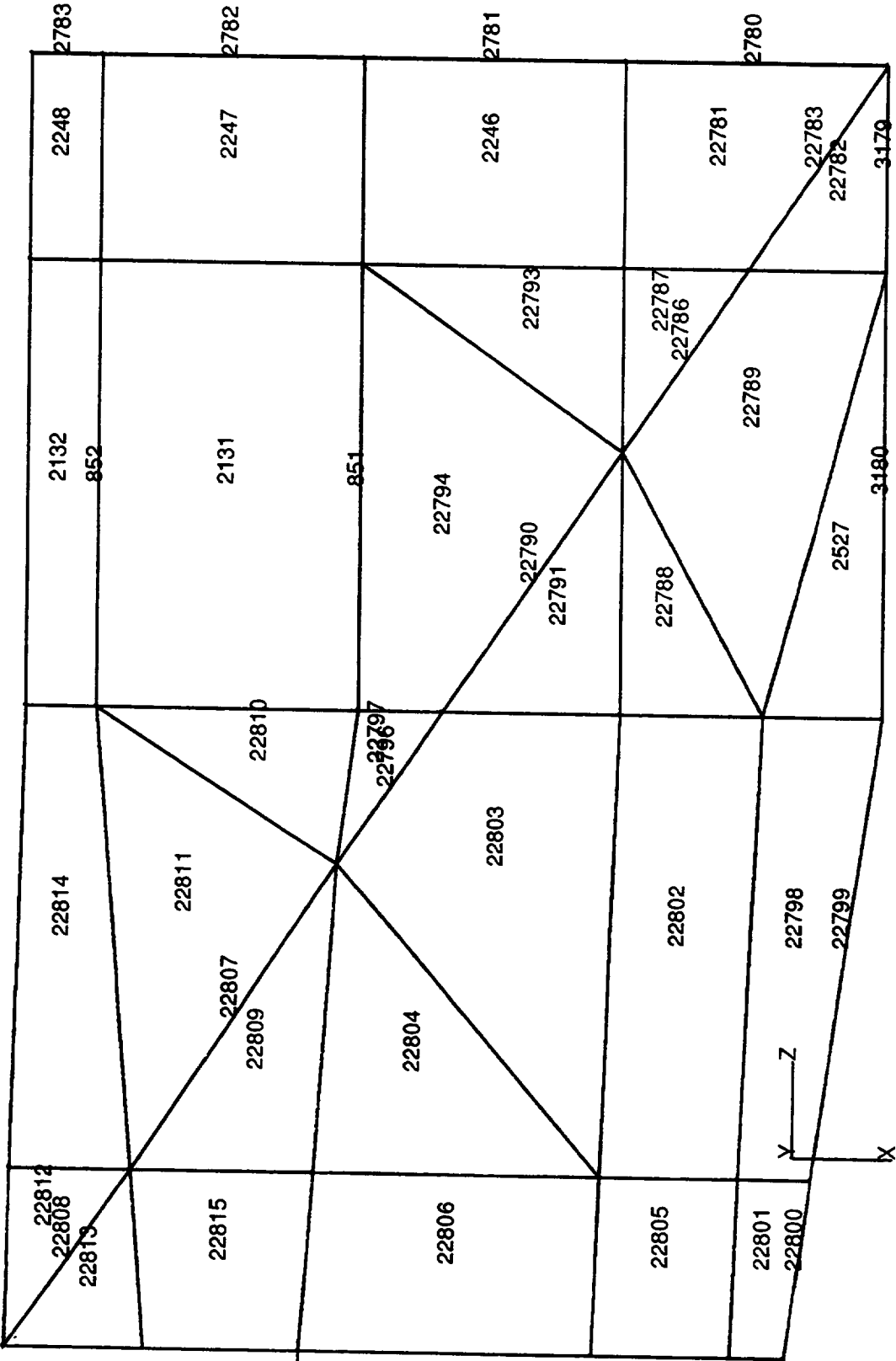


Figure A-13 Side Shelf Support Panel (DWG 1331218) Elements

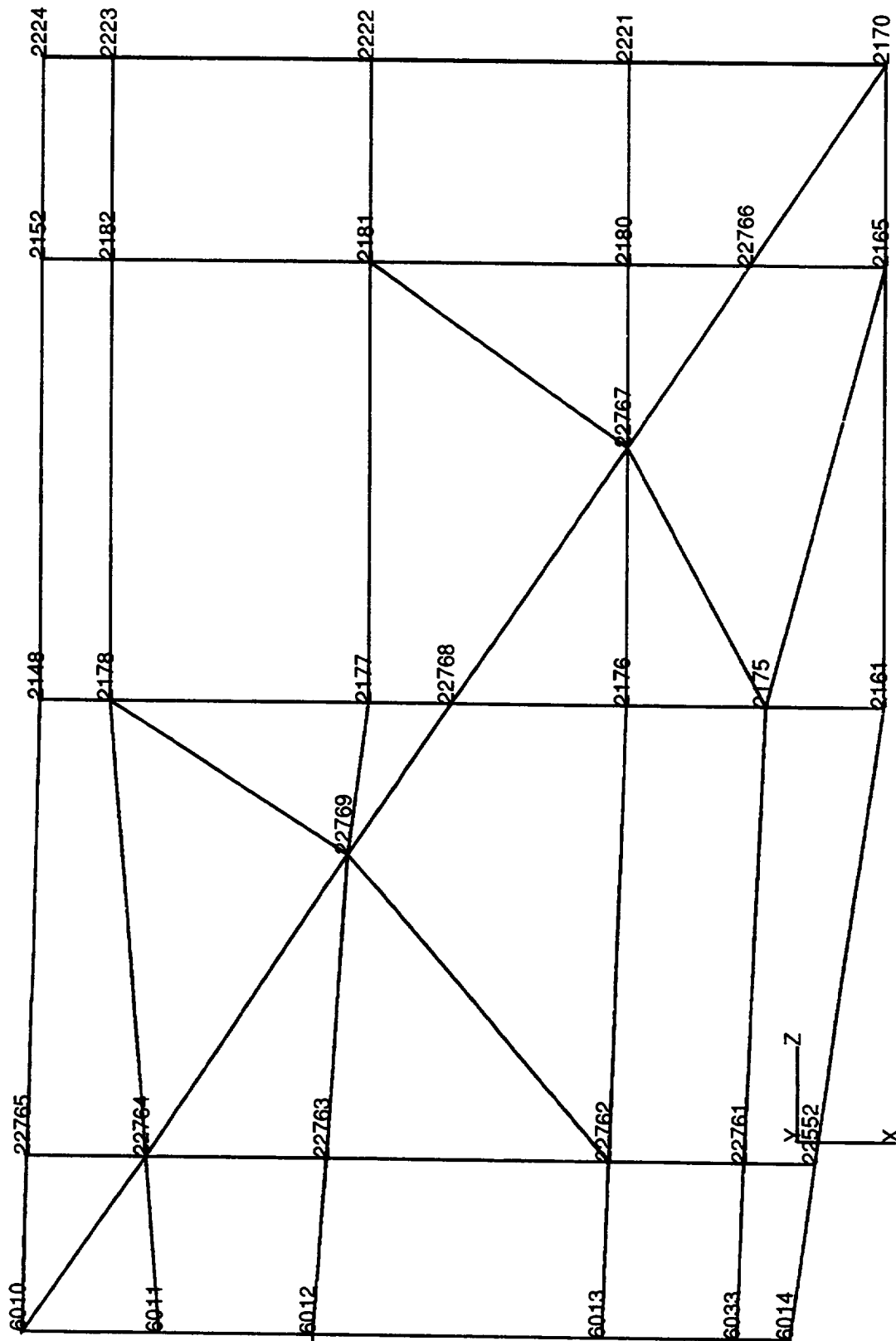


Figure A-14 Side Shelf Support Panel (DWG 1331218) Grid Points

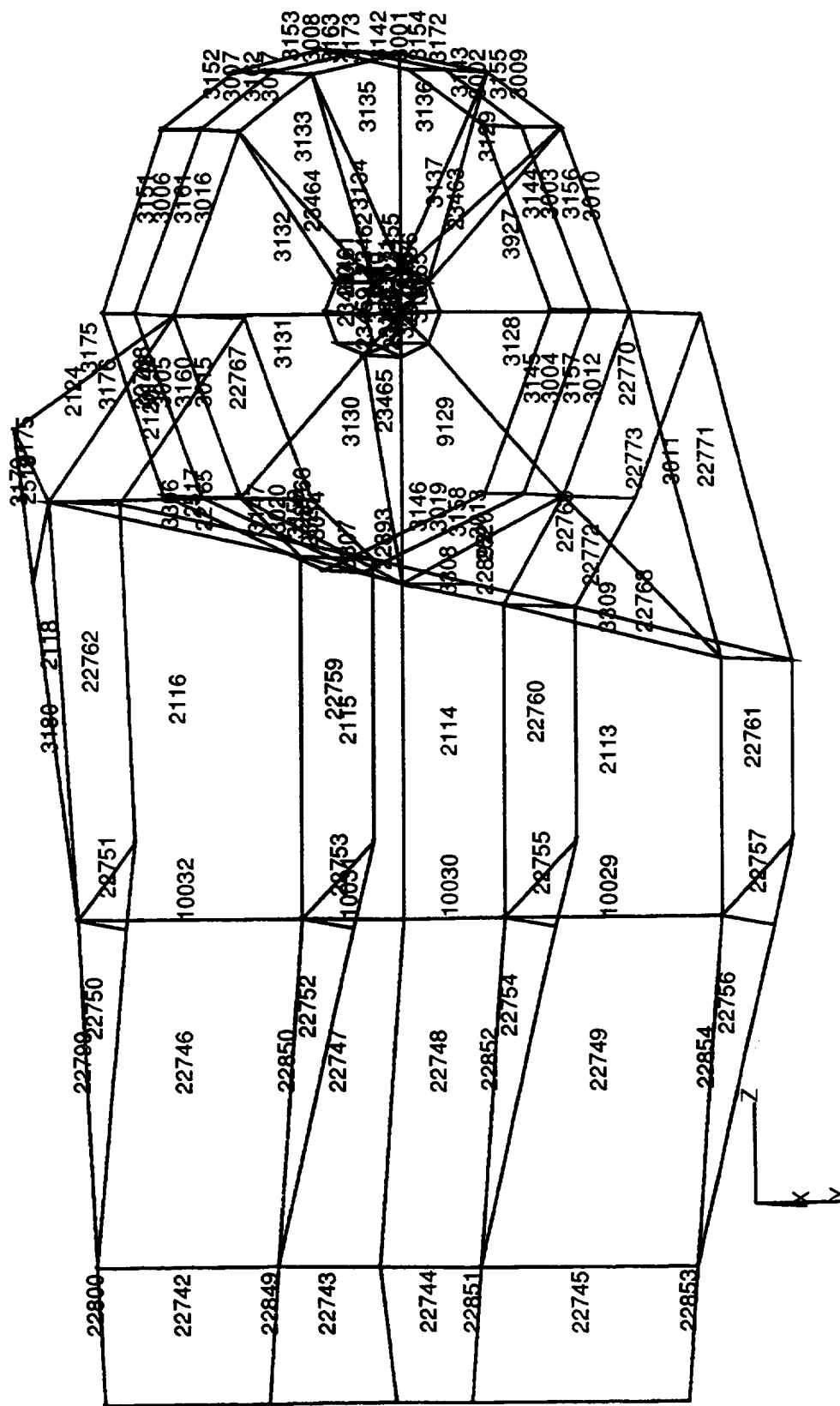


Figure A-15 Motor Support Front Panel (DWG 1331214) Elements

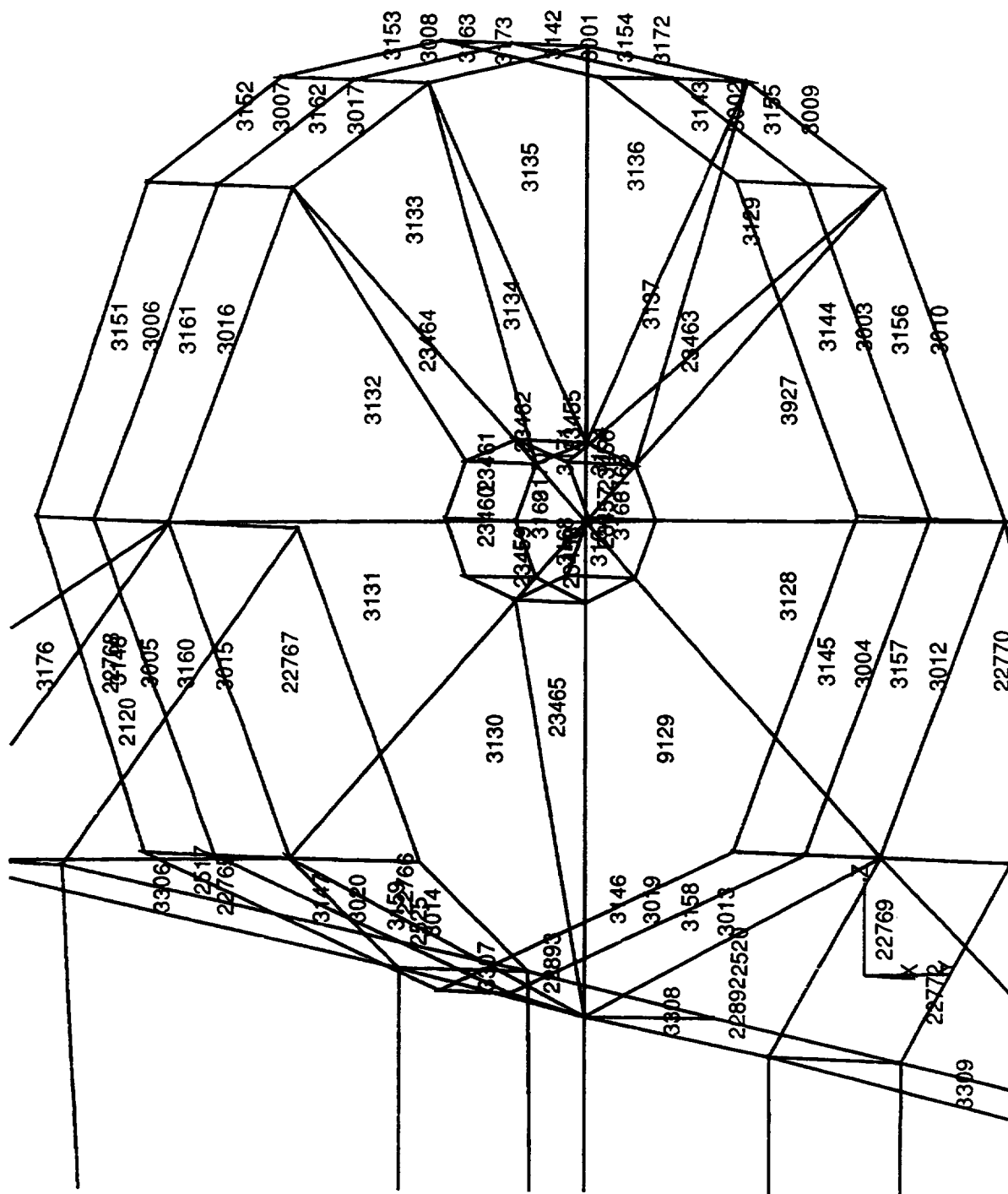


Figure A-16 Motor Support Front Panel Elements



Figure A-17 Motor Support Front Panel Grid Points

Figure A-18 Motor Support Front Panel Grid Points

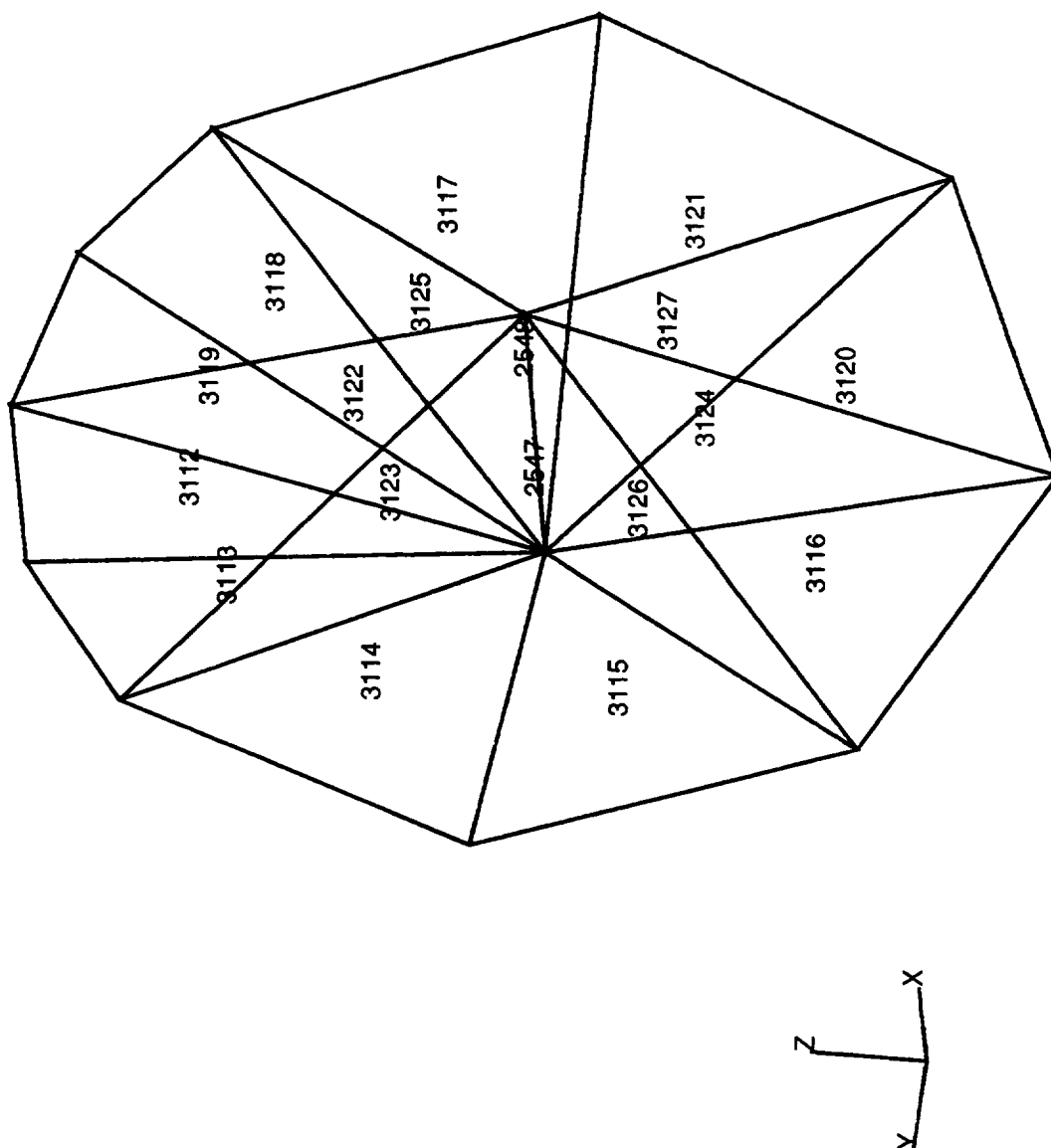


Figure A-19 Reflector Drive Elements

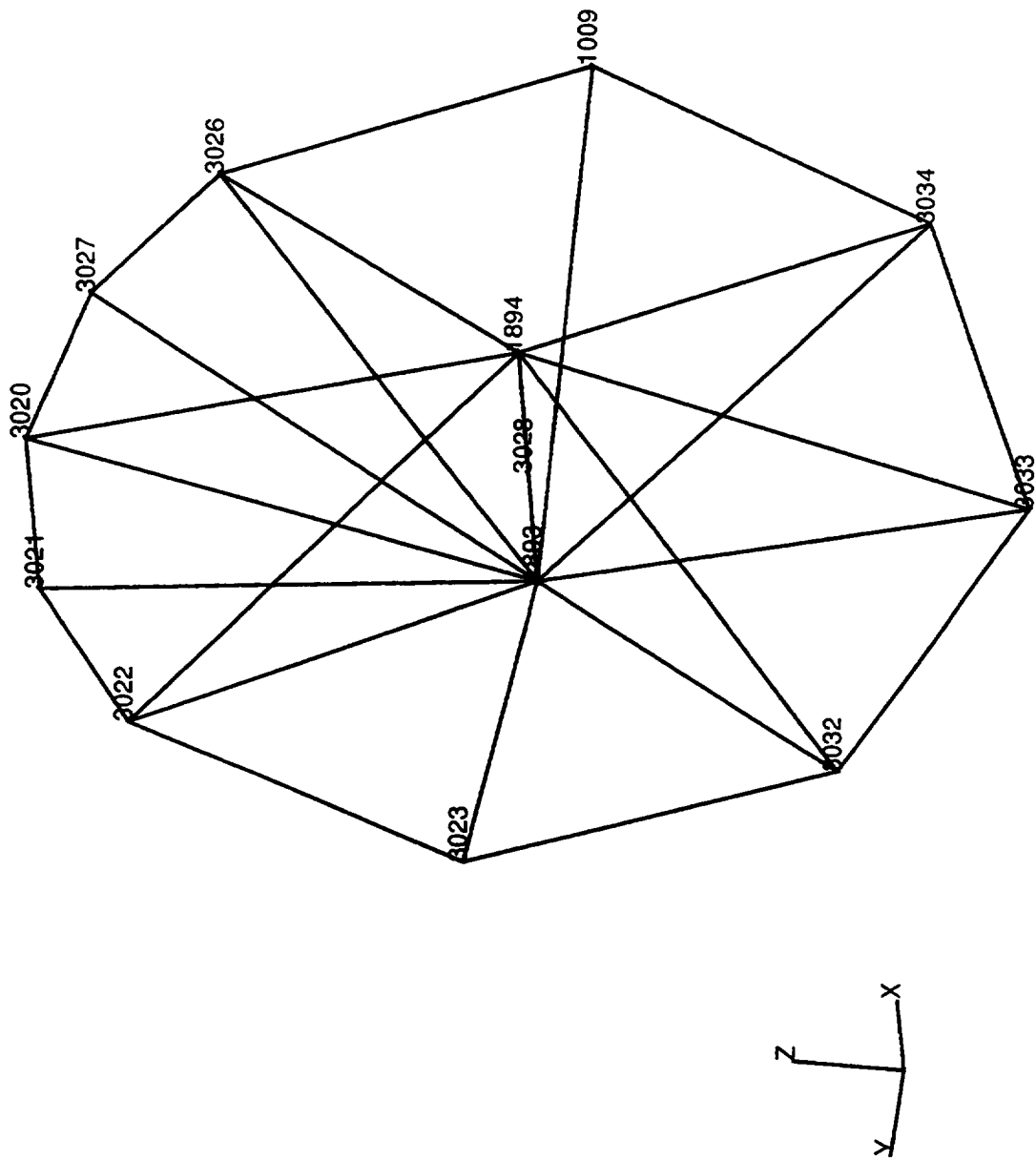


Figure A-20 Reflector Drive Grid Points



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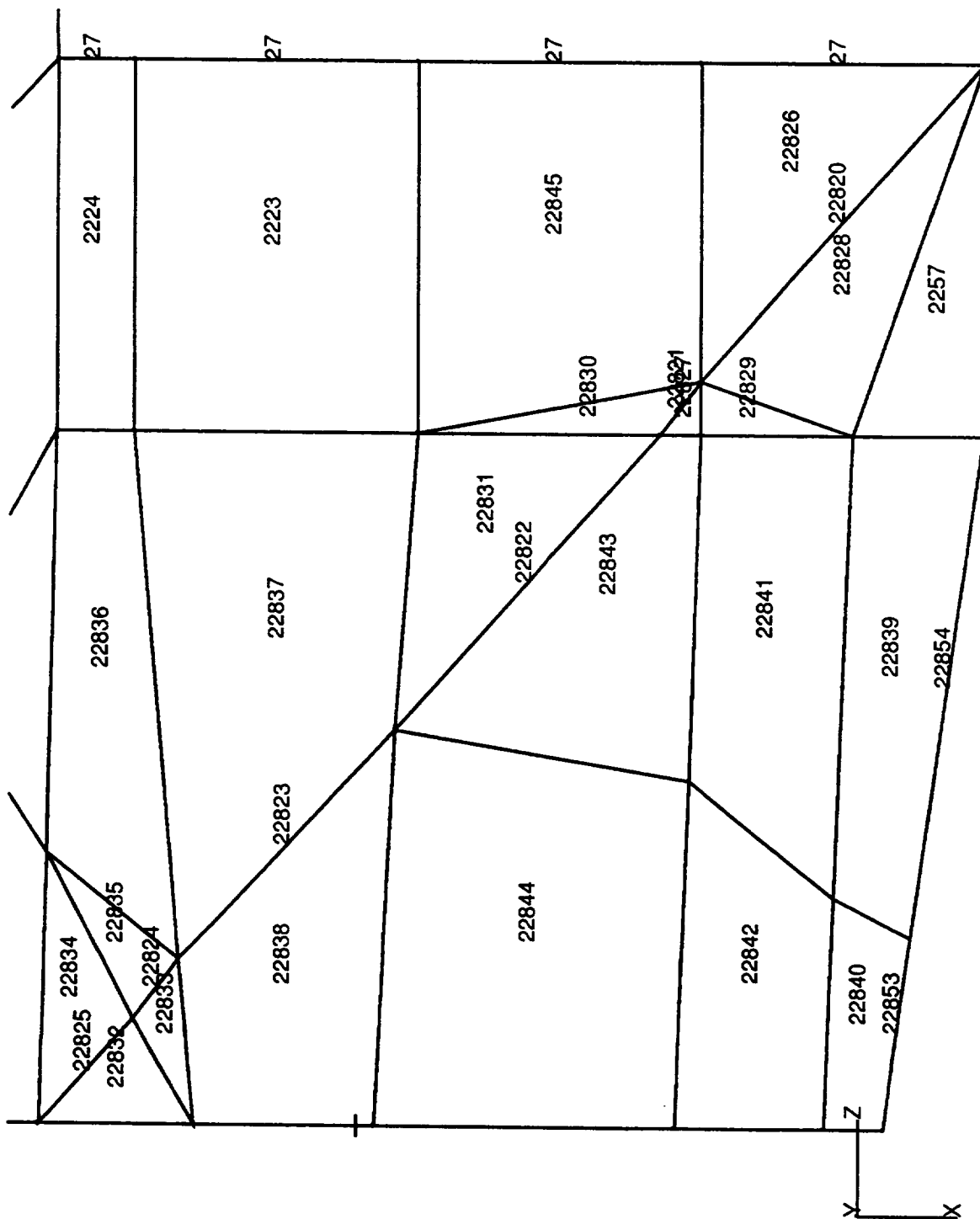
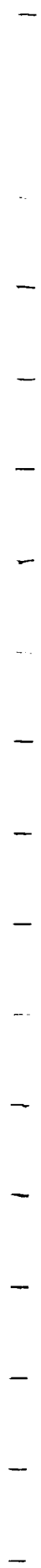


Figure A-22 Shelf Support Side Panel Elements



1

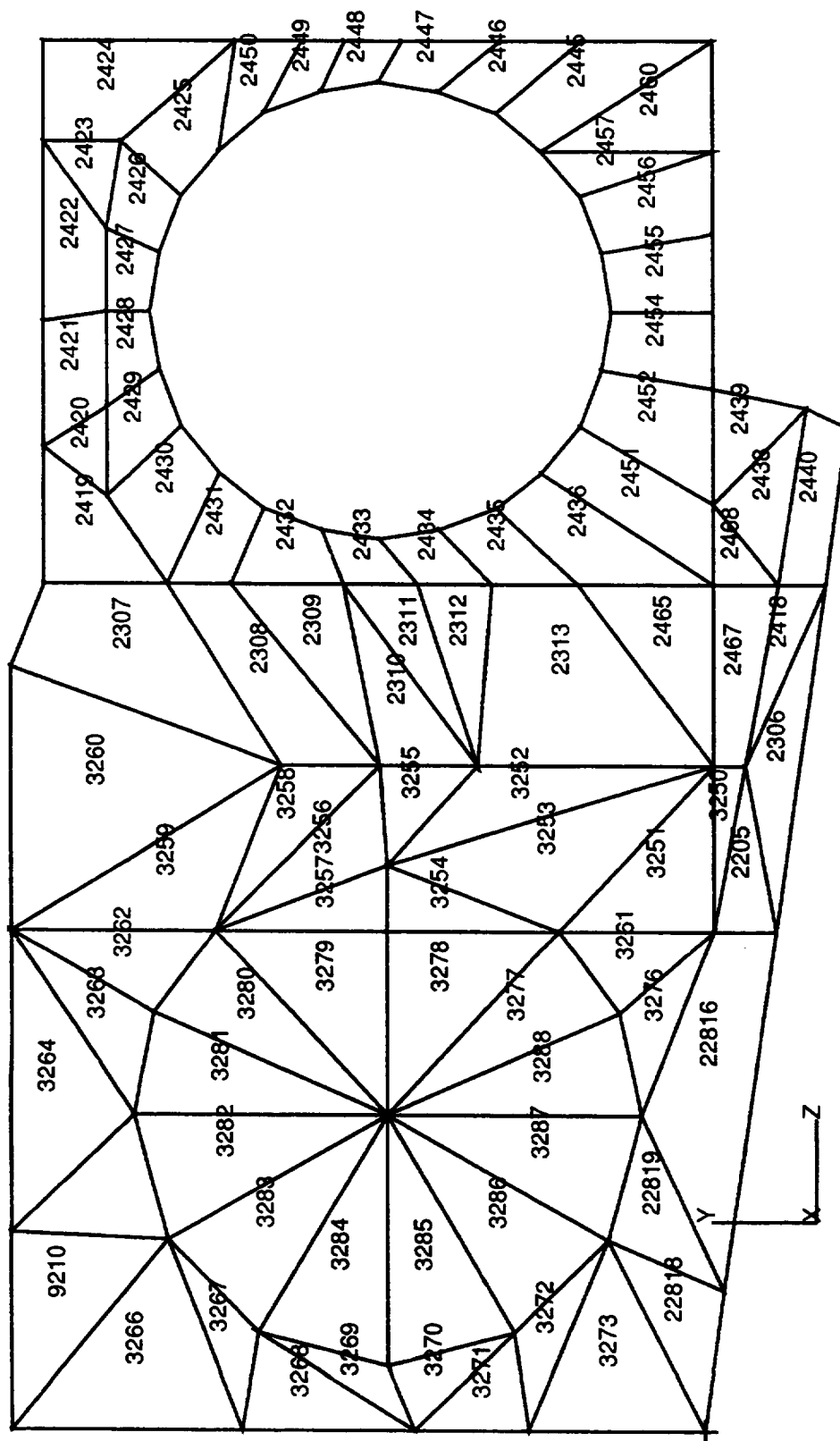
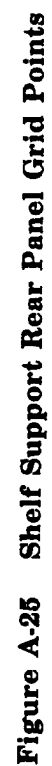


Figure A-24 Shelf Support Rear Panel (DWG 1331215) Elements



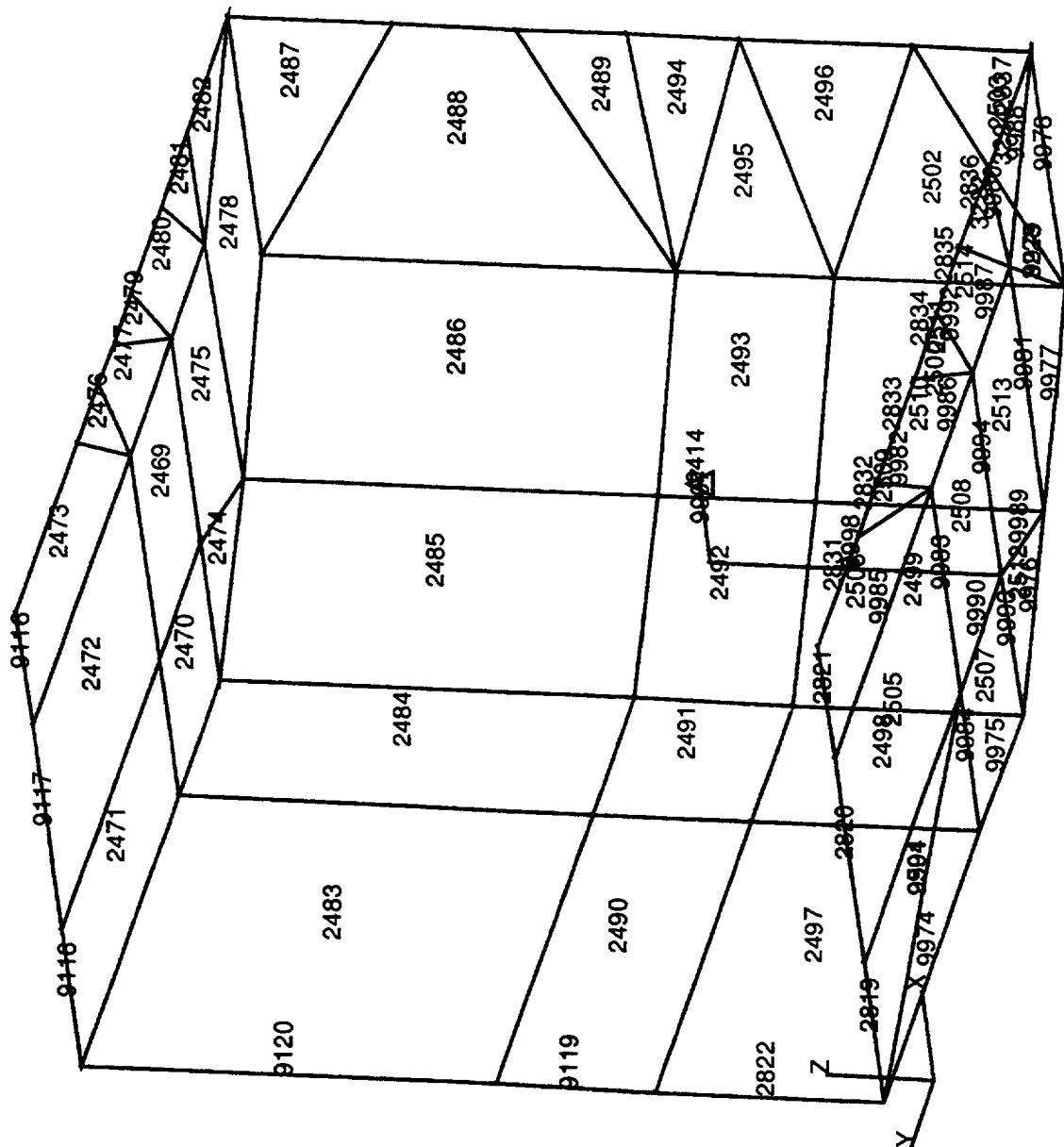


Figure A-26 Secondary Housing (DWG 1331228) Elements

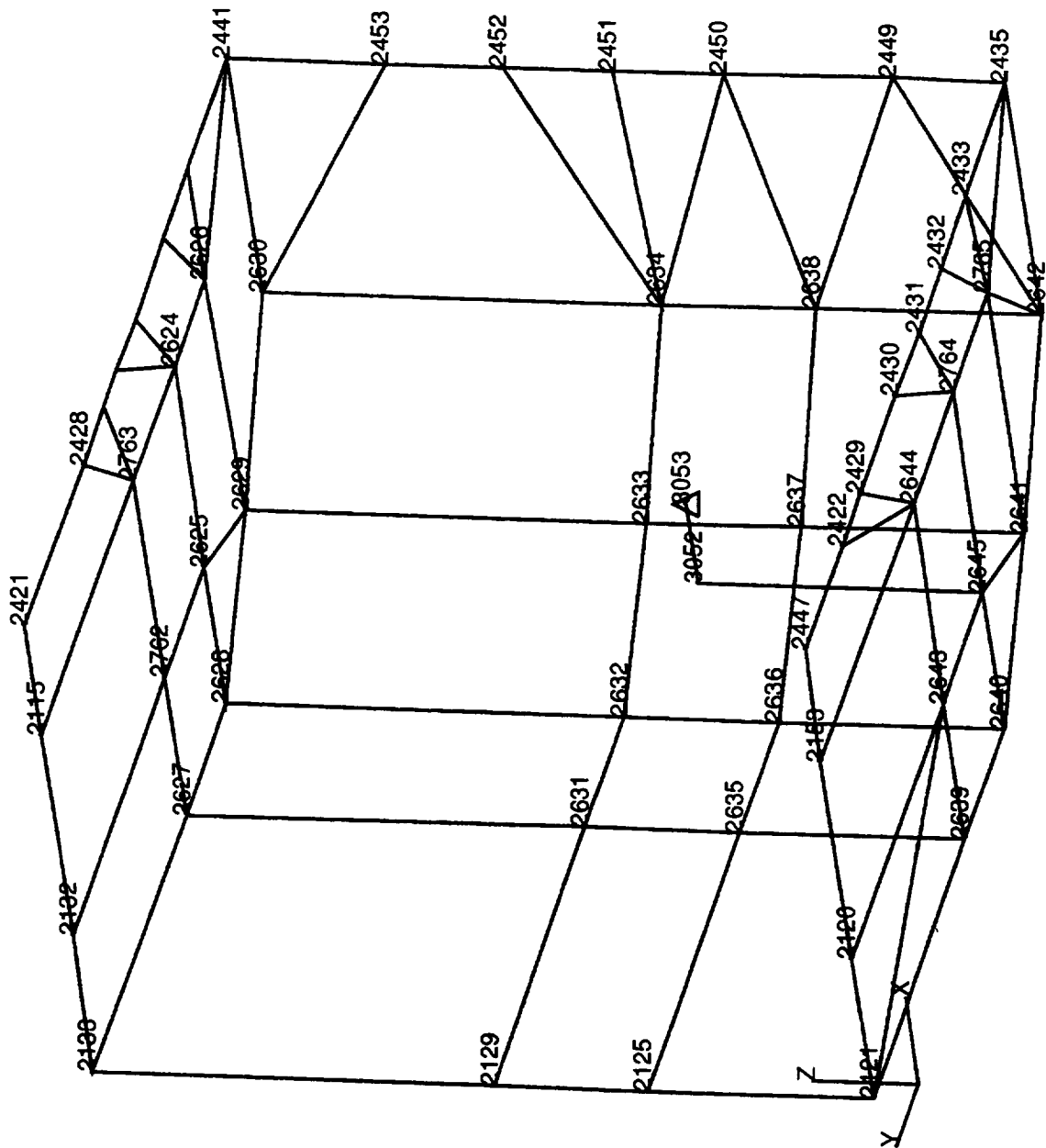


Figure A-27 Secondary Housing Grid Points

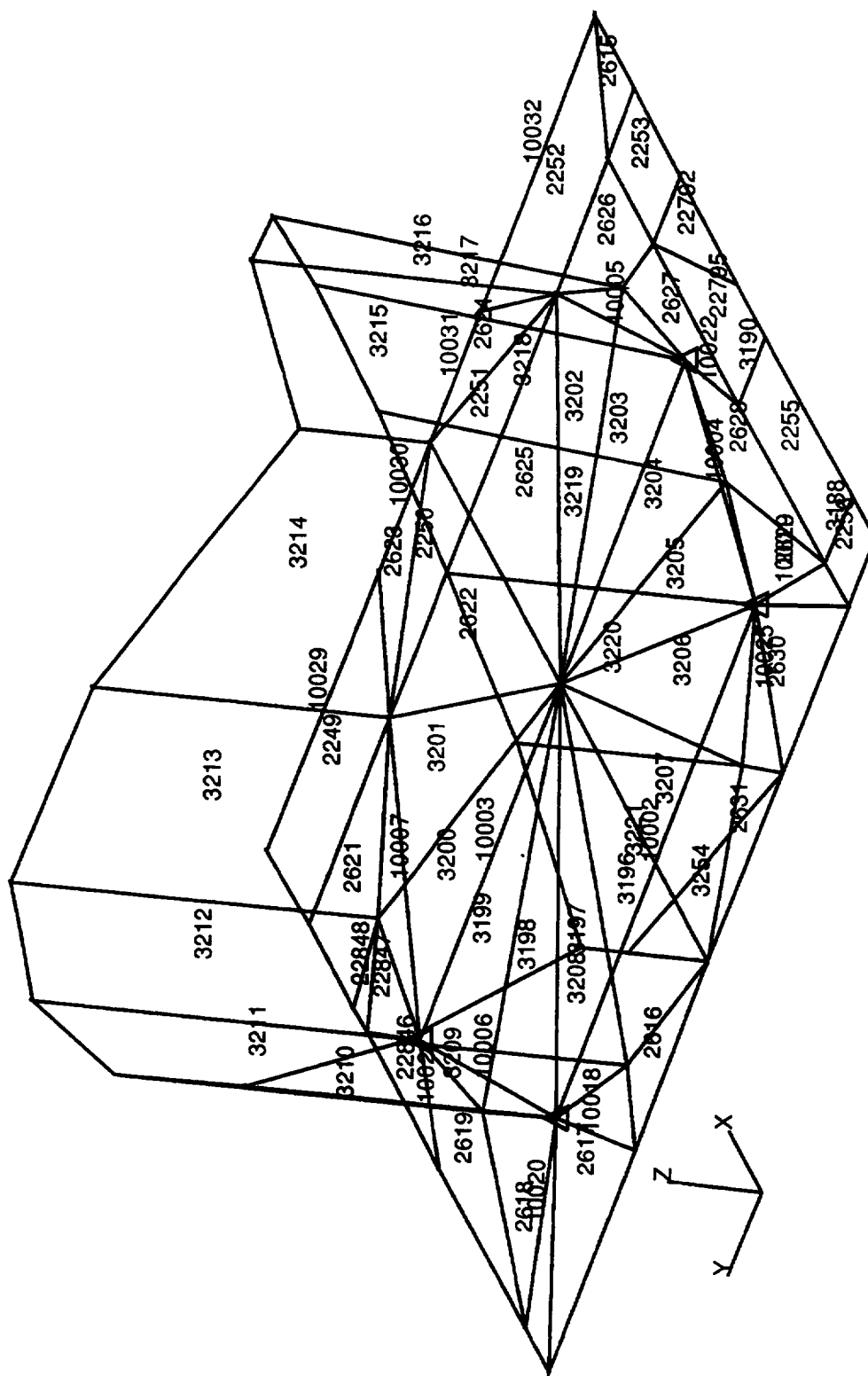


Figure A-28 Warm Load and Support Plate Elements

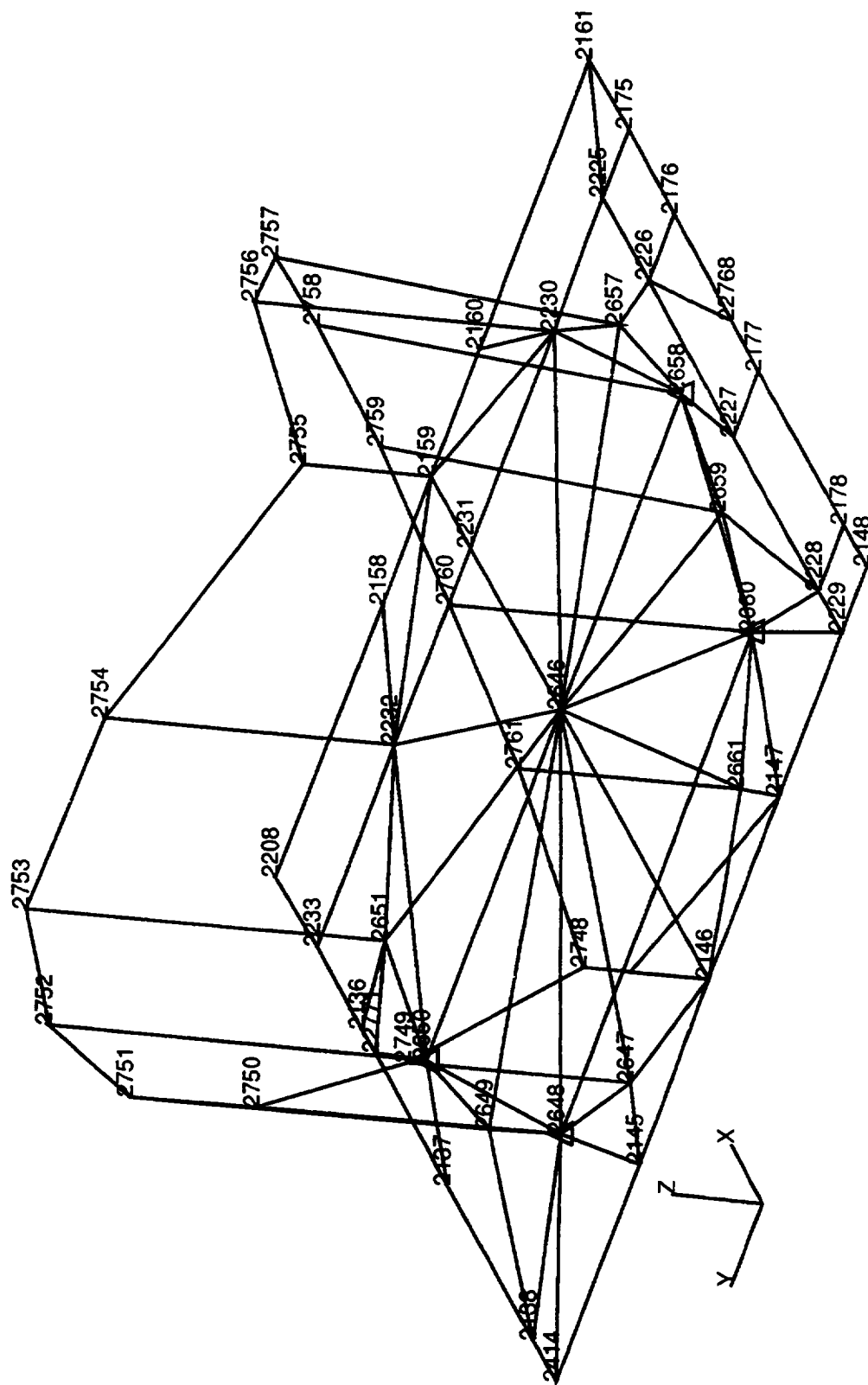


Figure A-29 Warm Load and Support Plate Grid Points

Figure A-30 Shelf Support Side Panel (DWG 1333379) Elements and Grid Points



Figure A-31 Shelf Support Side Panel Elements and Grid Points

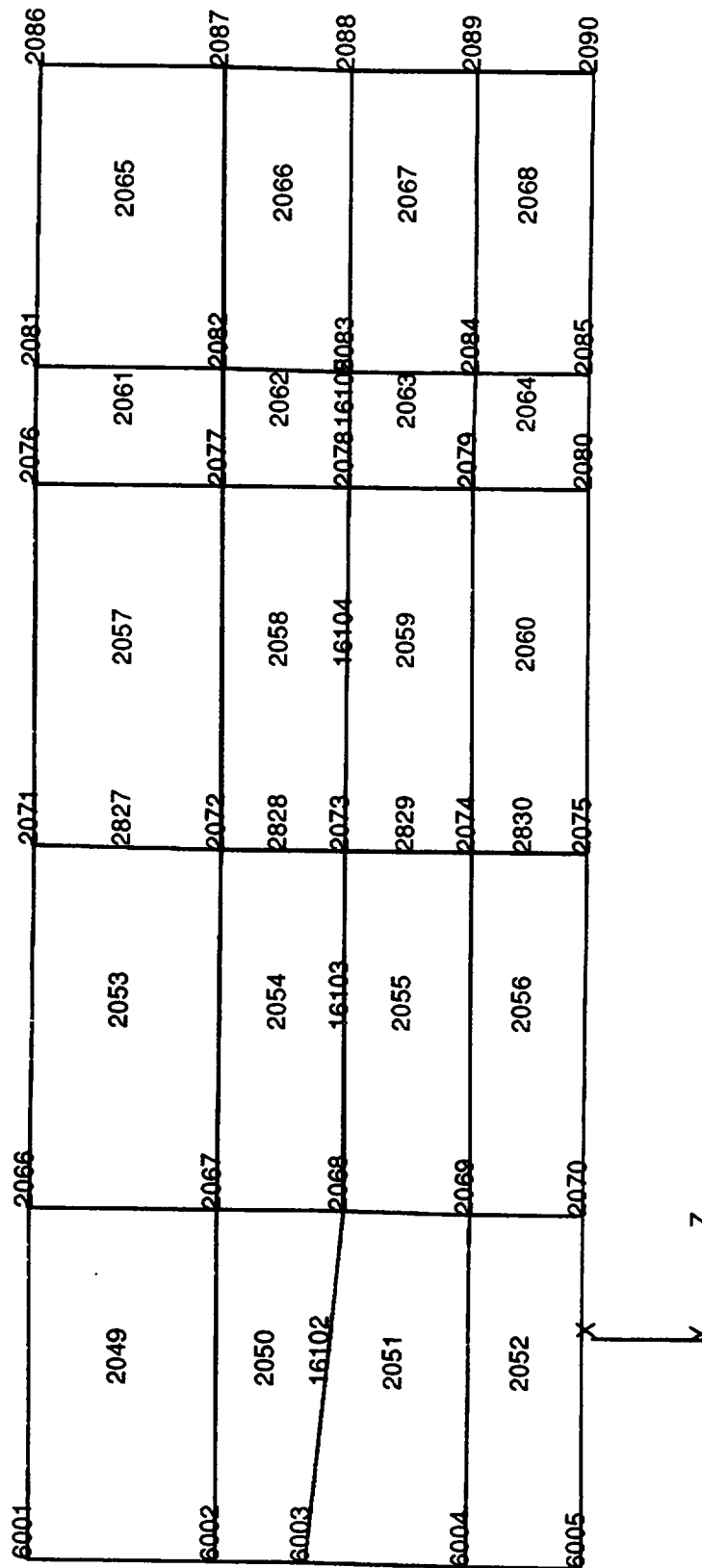


Figure A-32 Shelf Support End Panel (DWG 1333380) Elements and Grid Points



Figure A-33 Shelf Support Side Panel (DWG 1391245) Elements and Grid Points

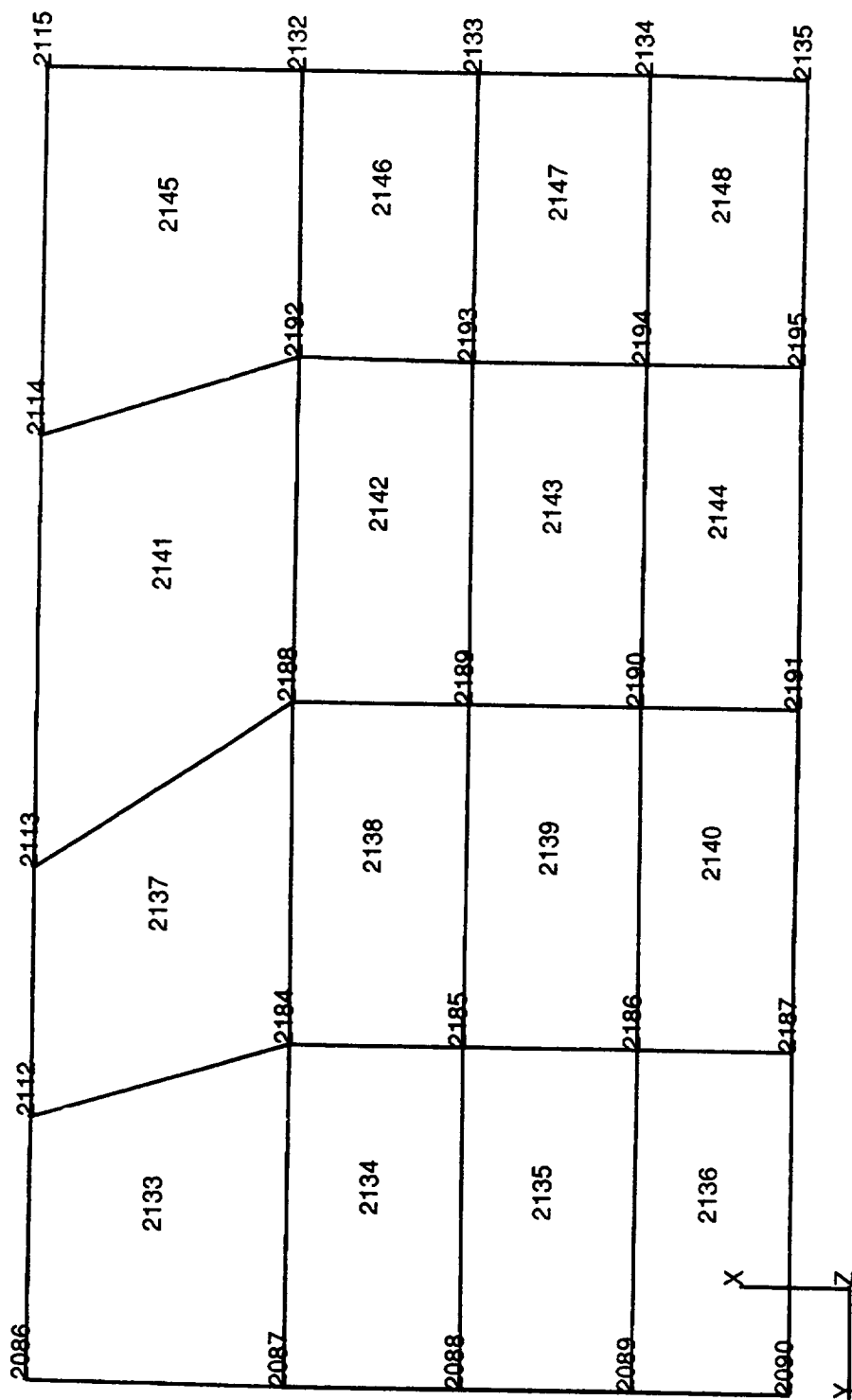


Figure A-34 Cover (DWG 1331244) Elements and Grid Points

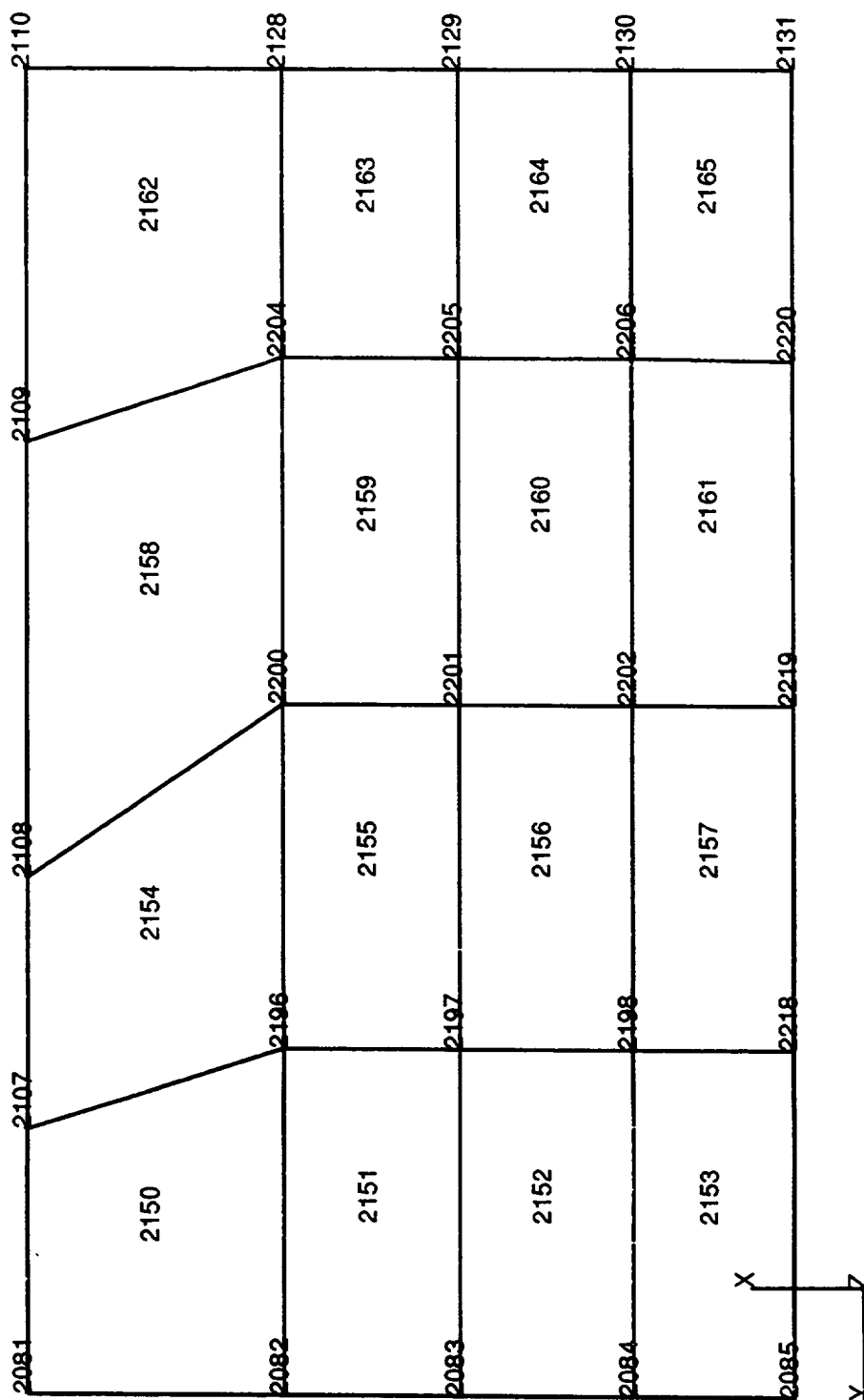


Figure A-35 Receiver Shelf Elements and Grid Points

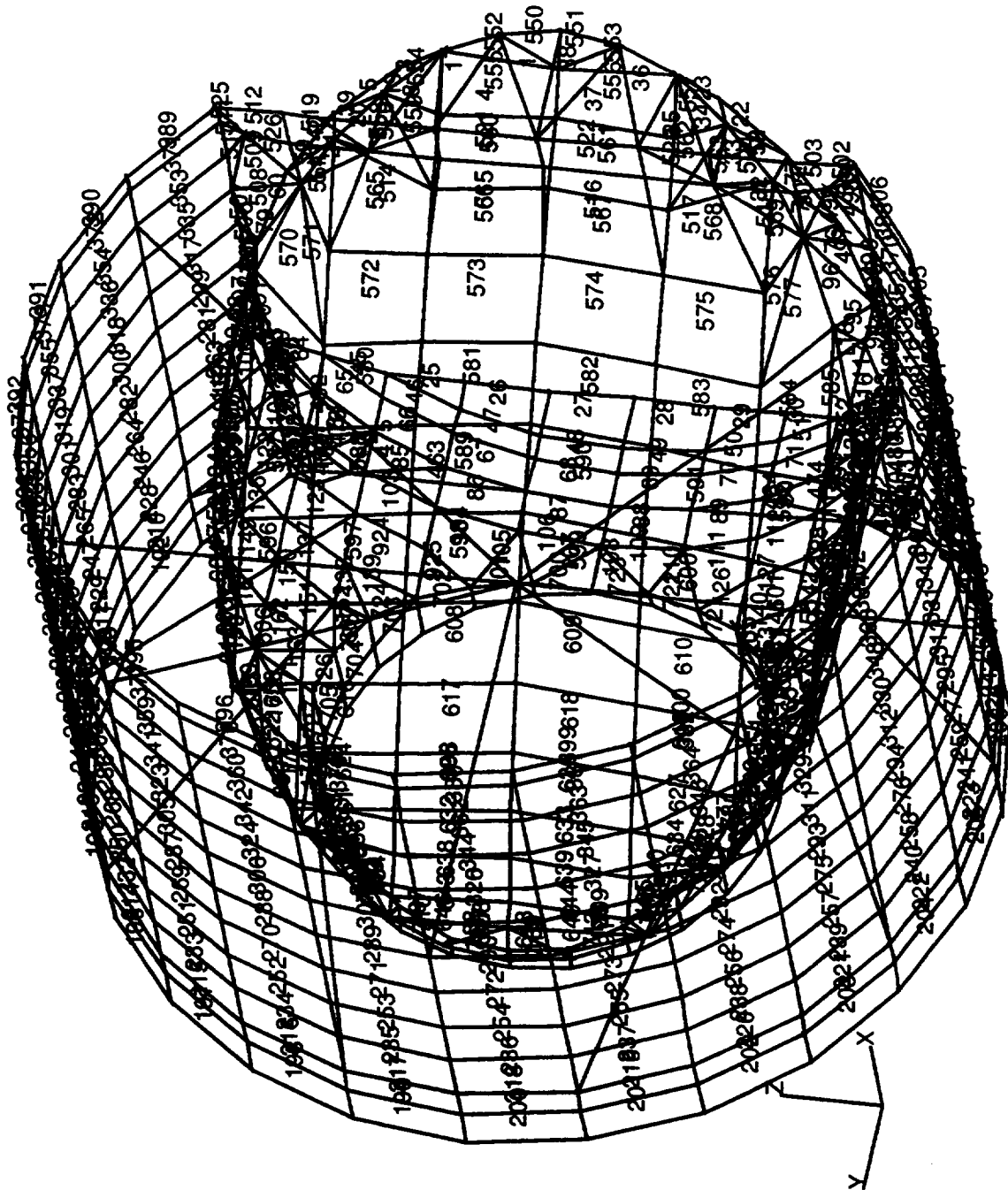


Figure A-36 Reflector Assembly Shell Elements

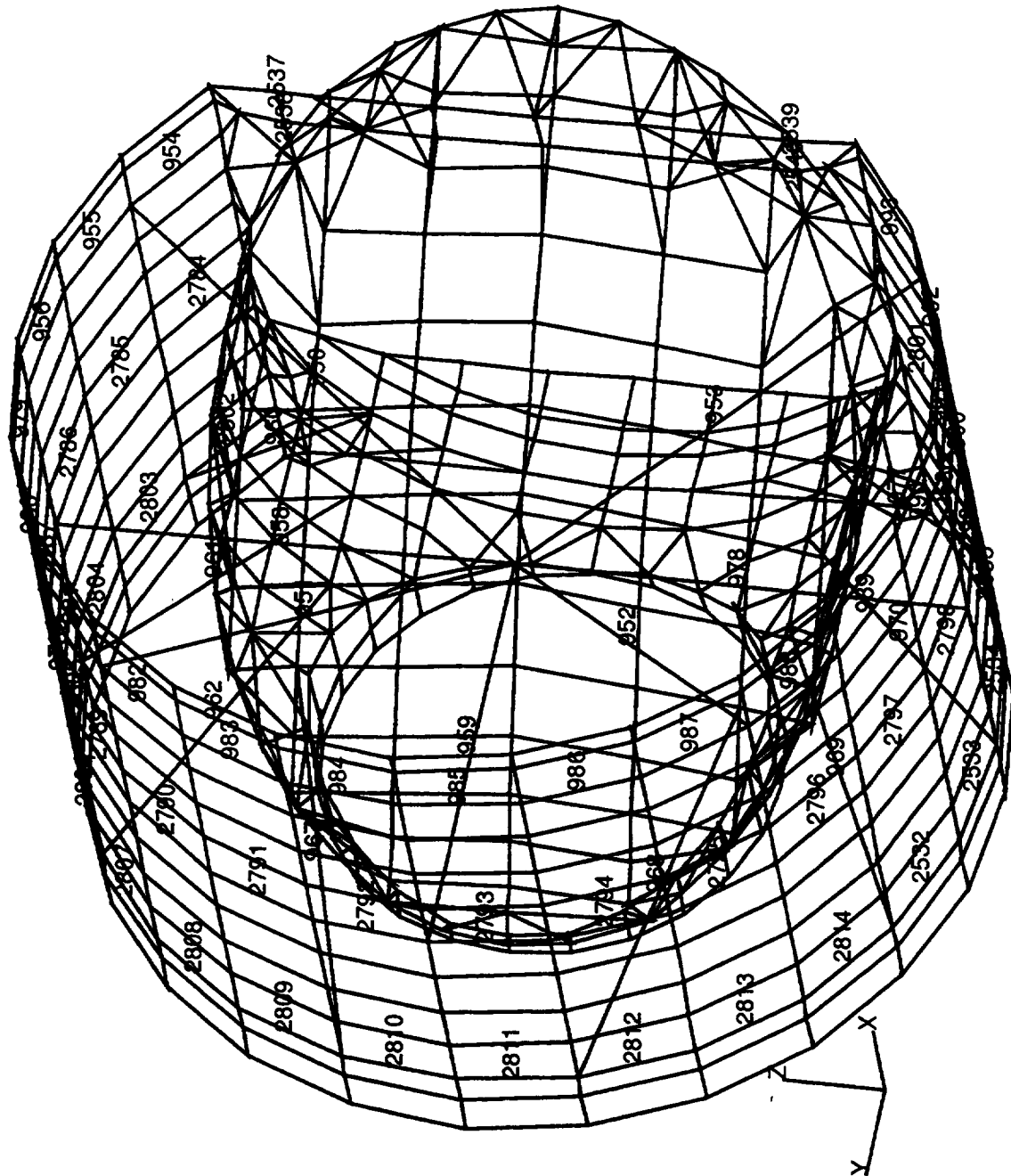


Figure A-37 Reflector Assembly Beam Elements

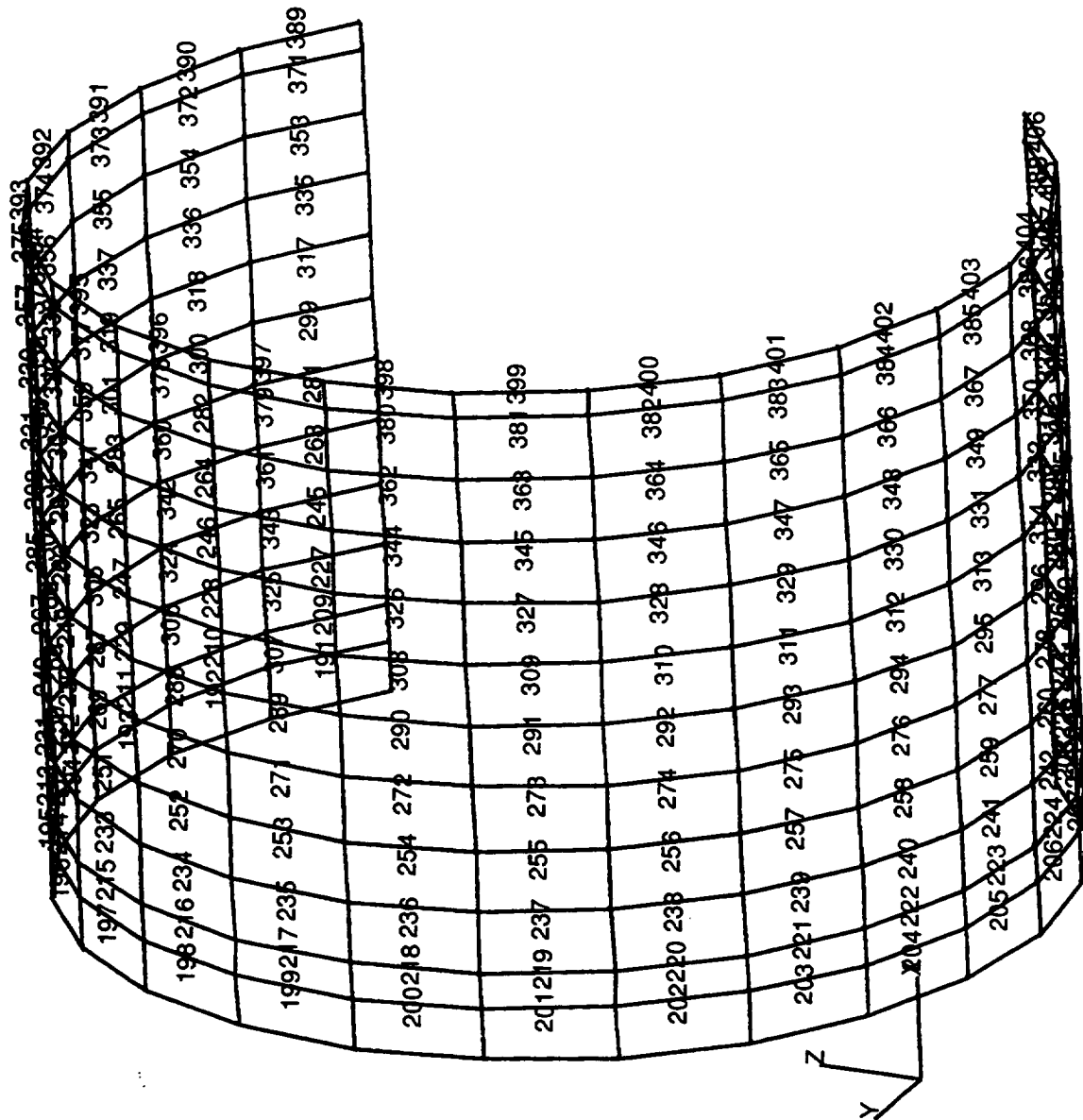


Figure A-38 Reflector Shroud Shell Elements

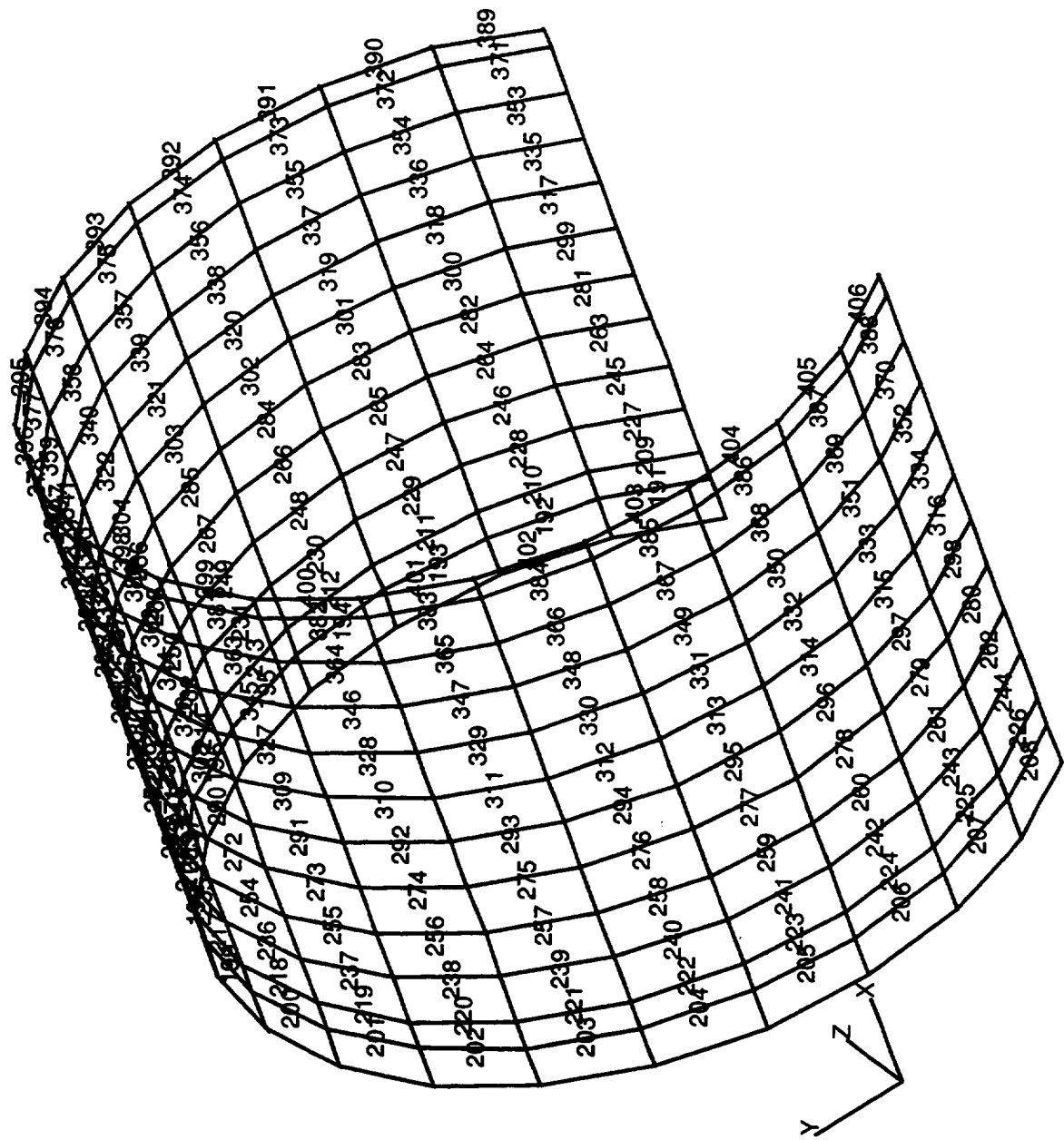


Figure A-39 Reflector Shroud Shell Elements

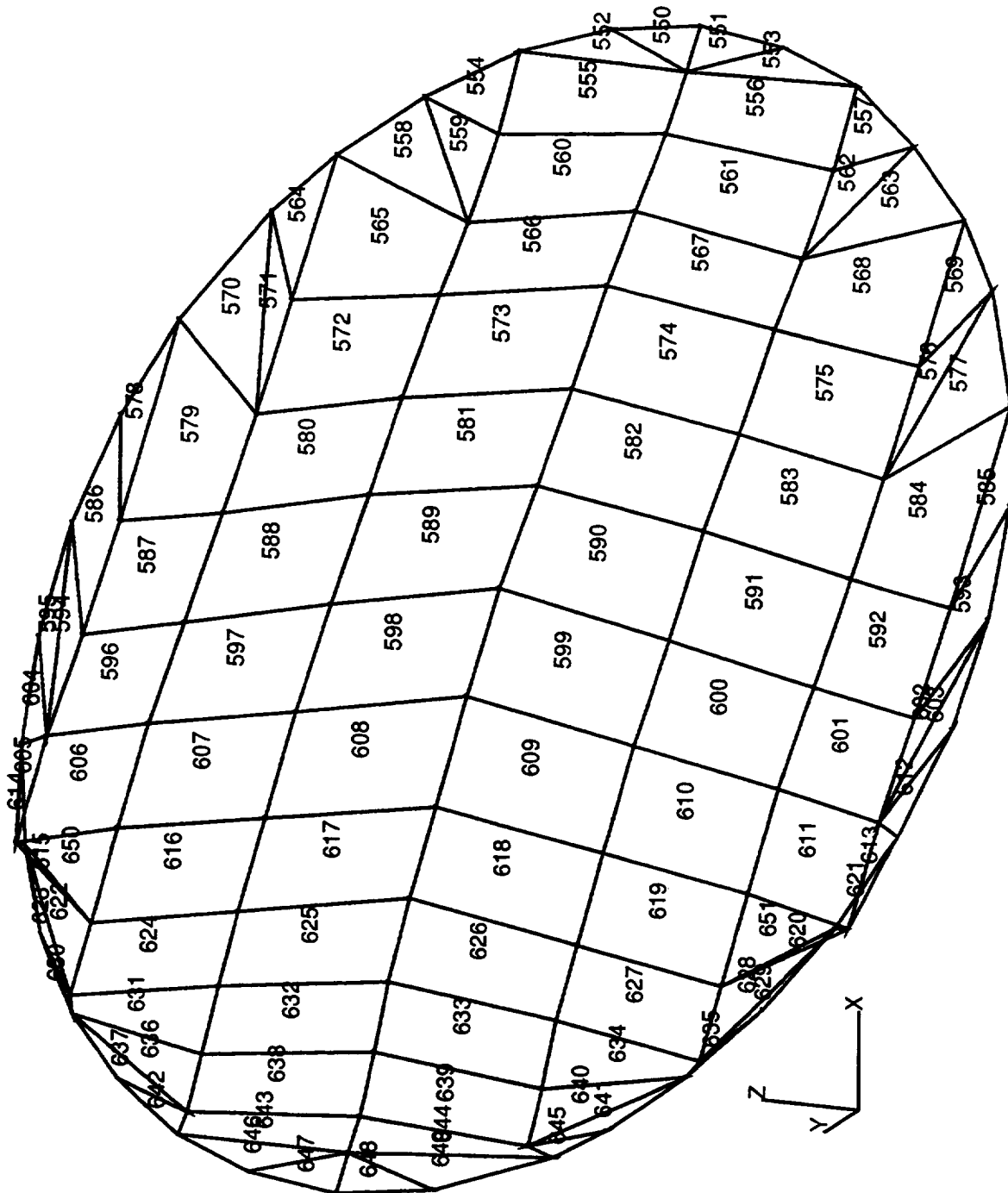


Figure A-40 Parabolic Shell Elements

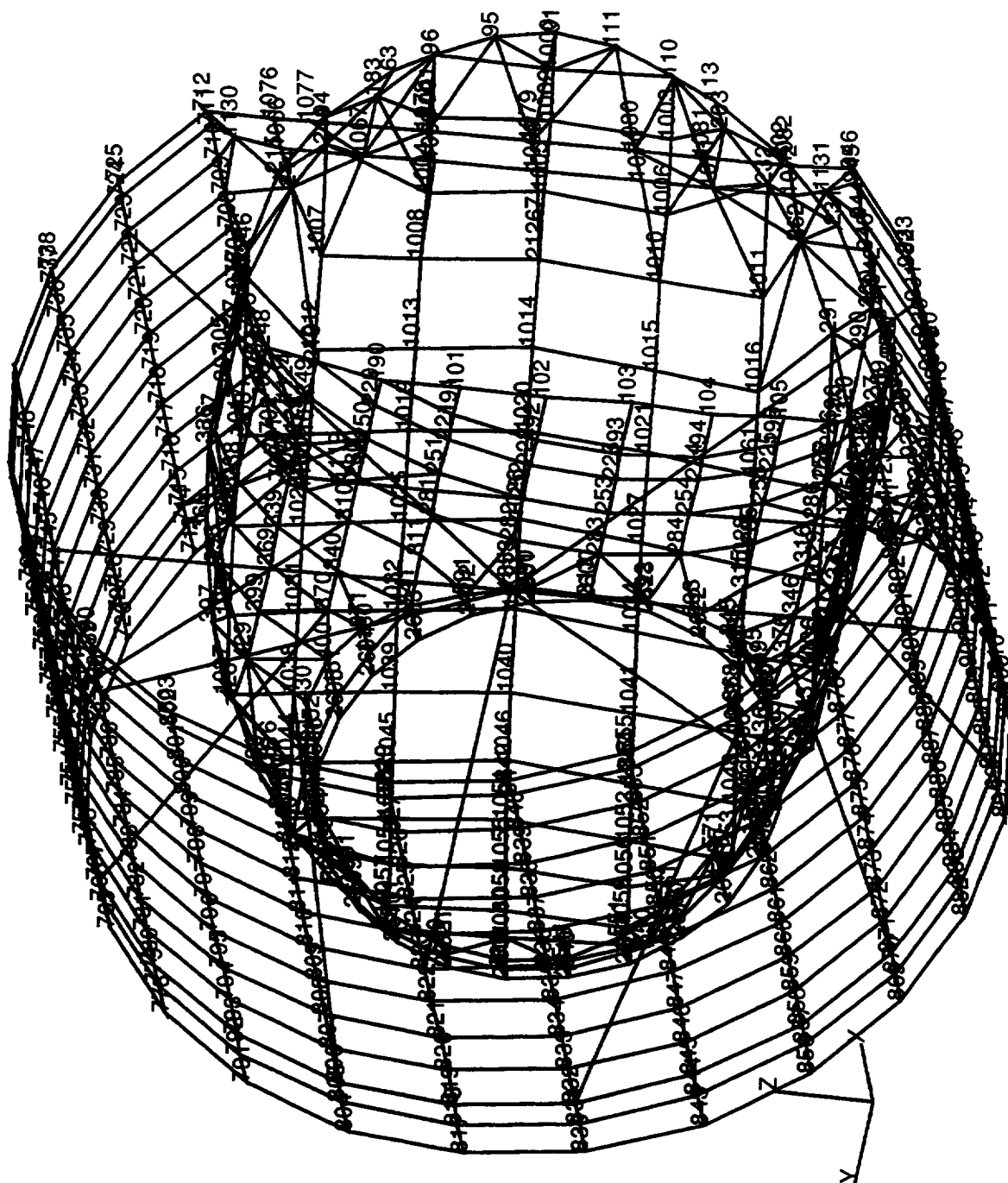


Figure A-41 Reflector Assembly Grid Points

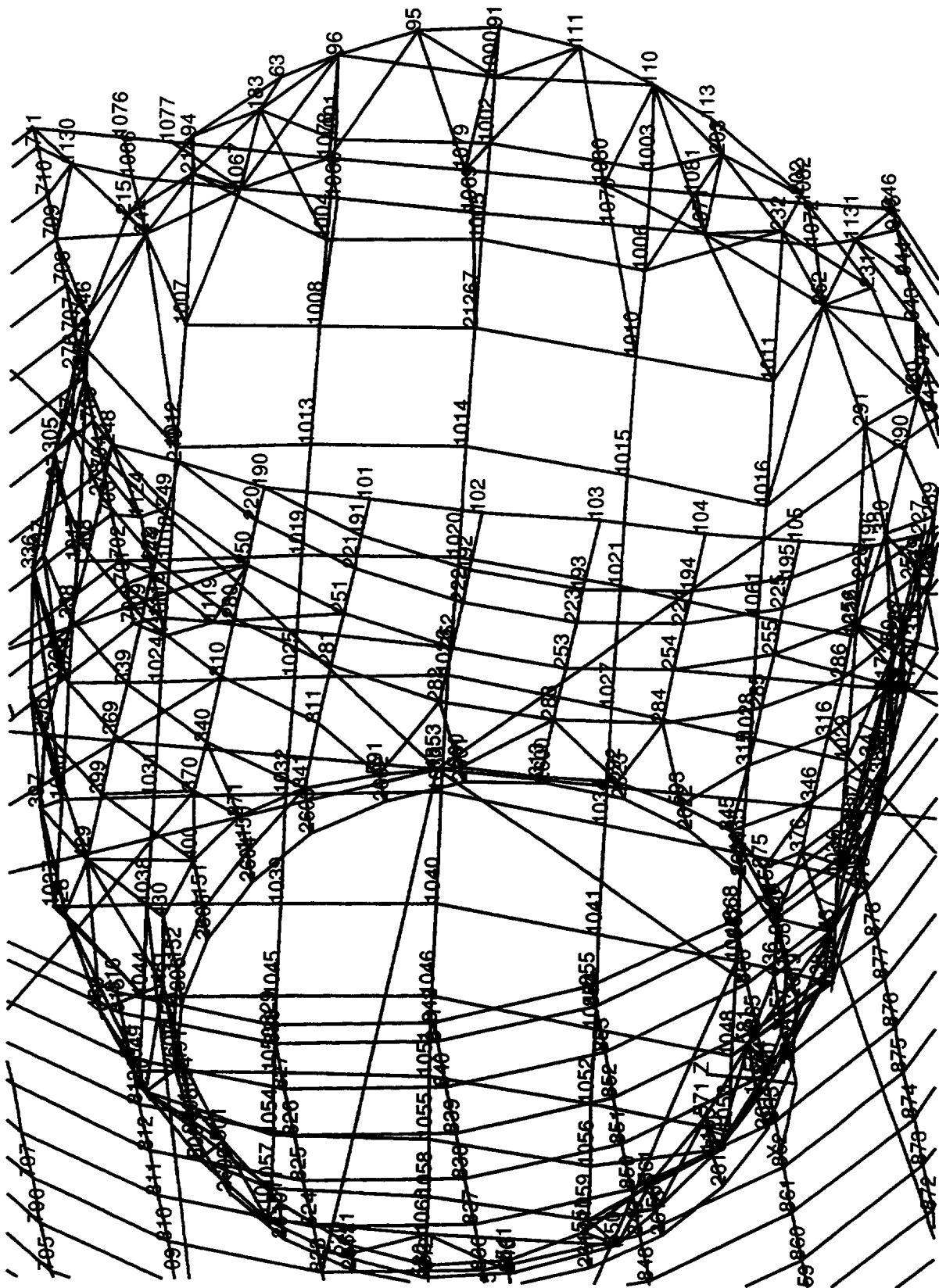


Figure A-42 Reflector Assembly Grid Points

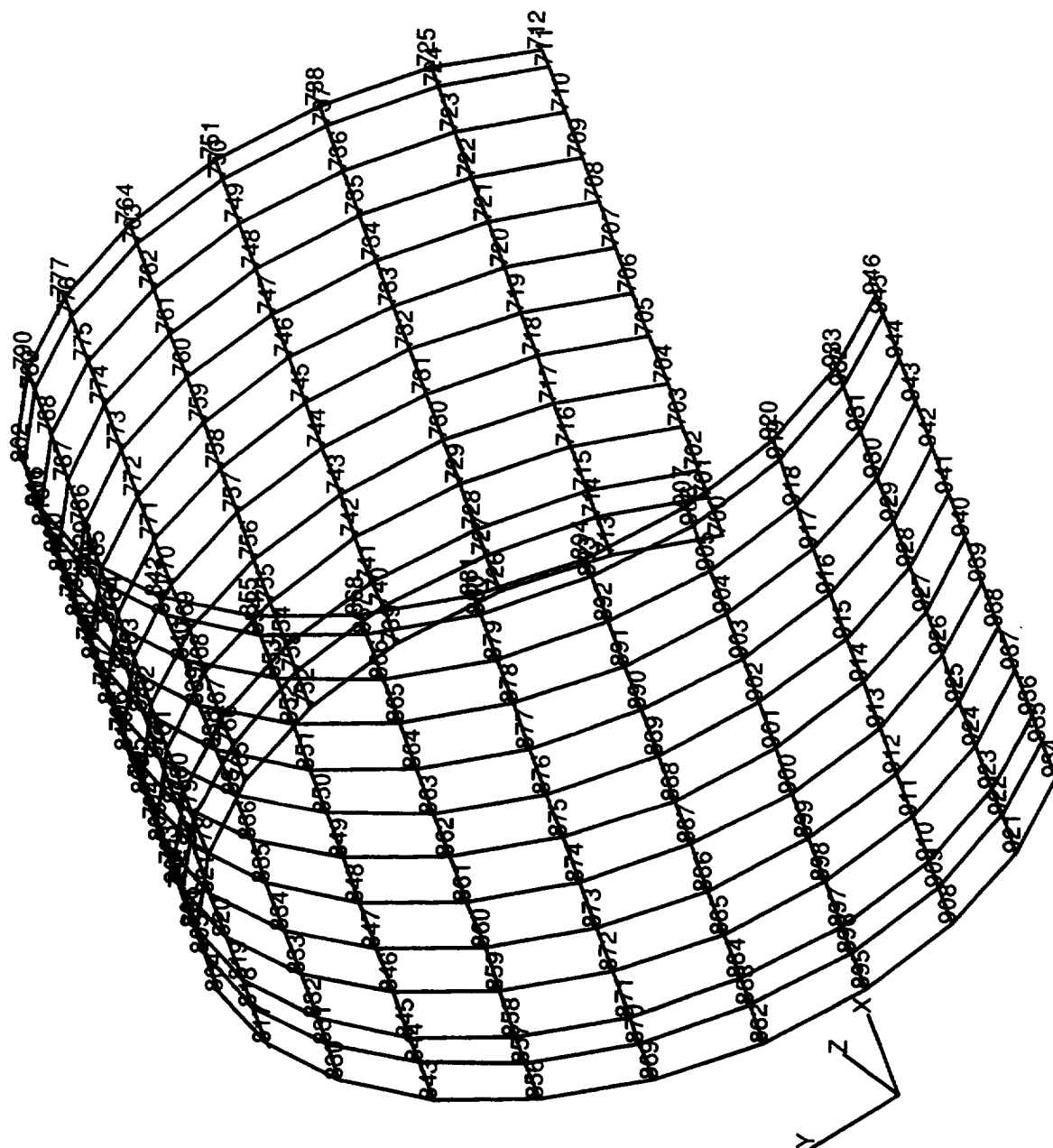


Figure A-43 Reflector Shroud Grid Points

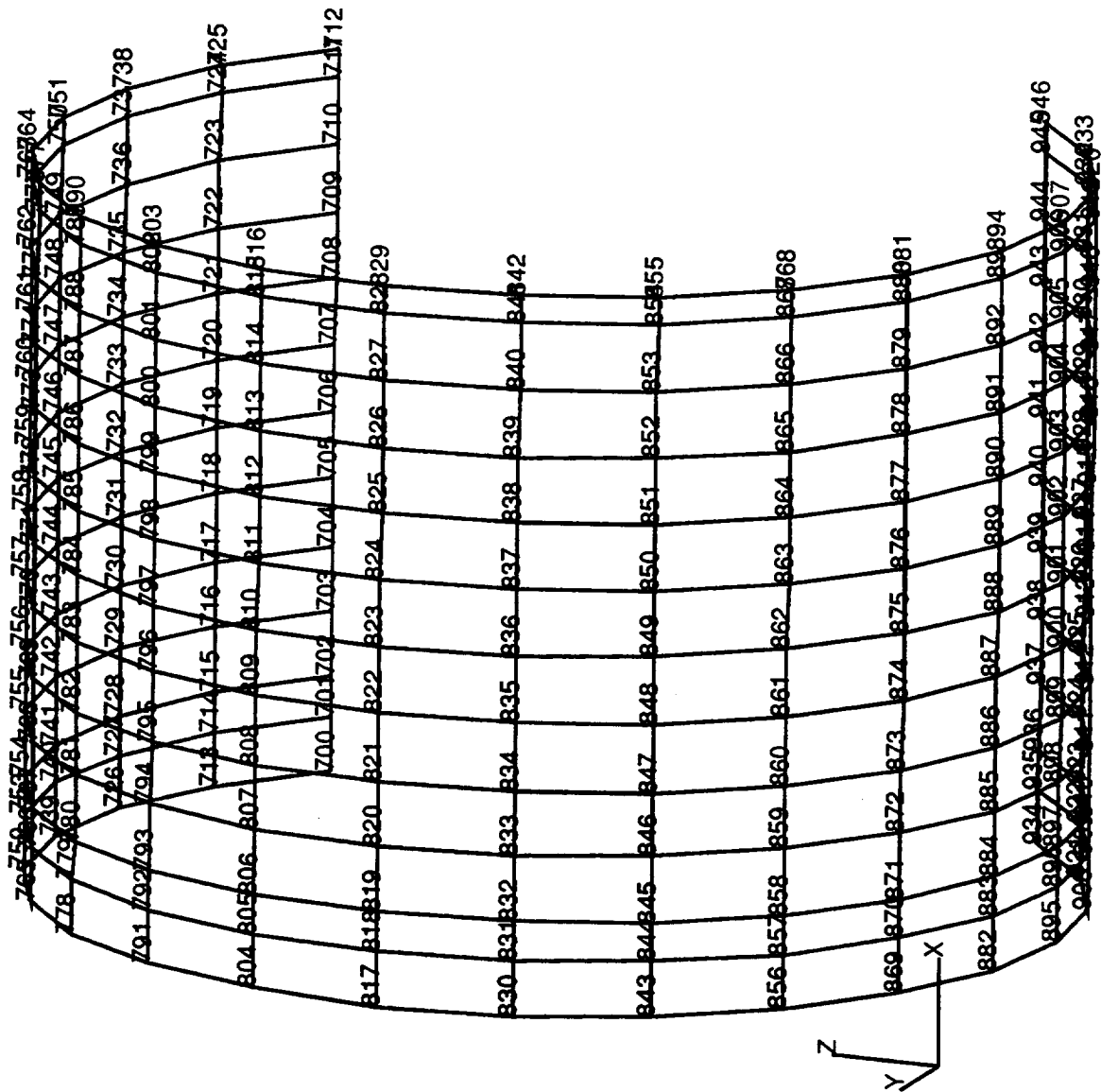


Figure A-44 Reflector Shroud Grid Points

Figure A-45 Parabolic Shell Grid Points

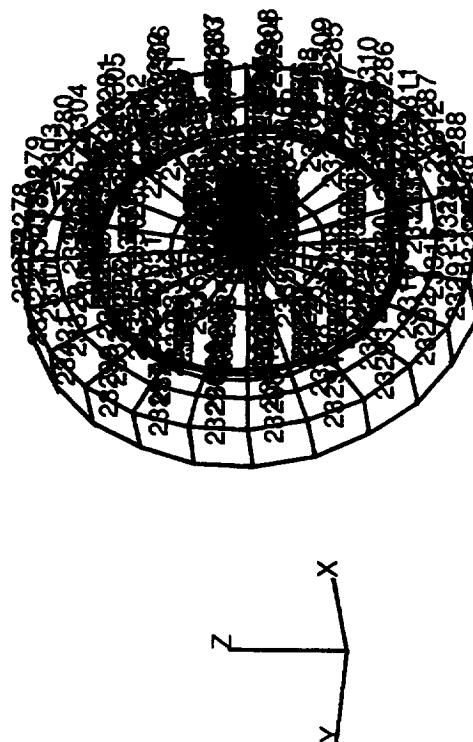


Figure A-46 Steel Components Compensator Rotor and Motor Shaft Elements

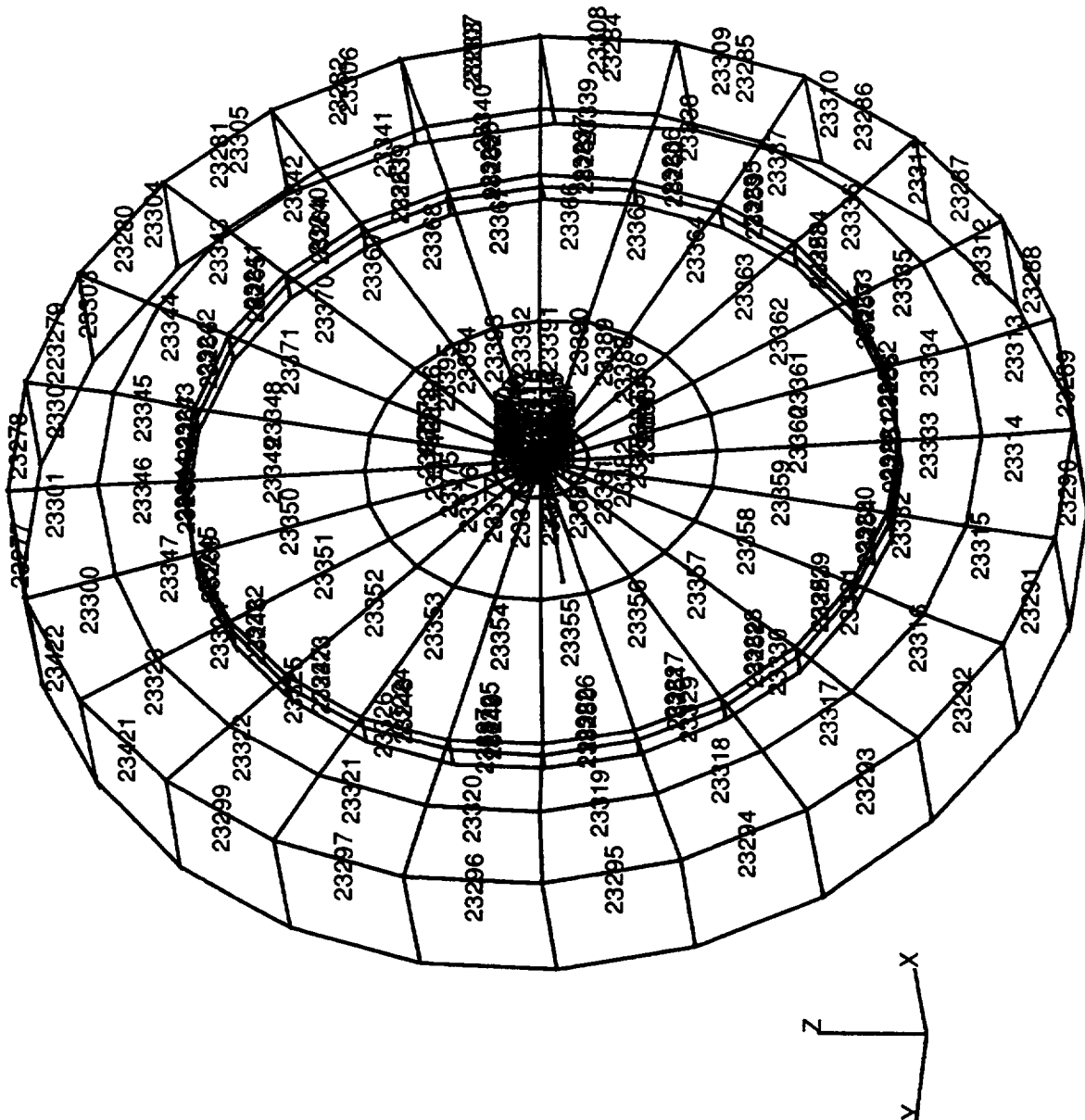


Figure A-47 Compensator Rotor Elements

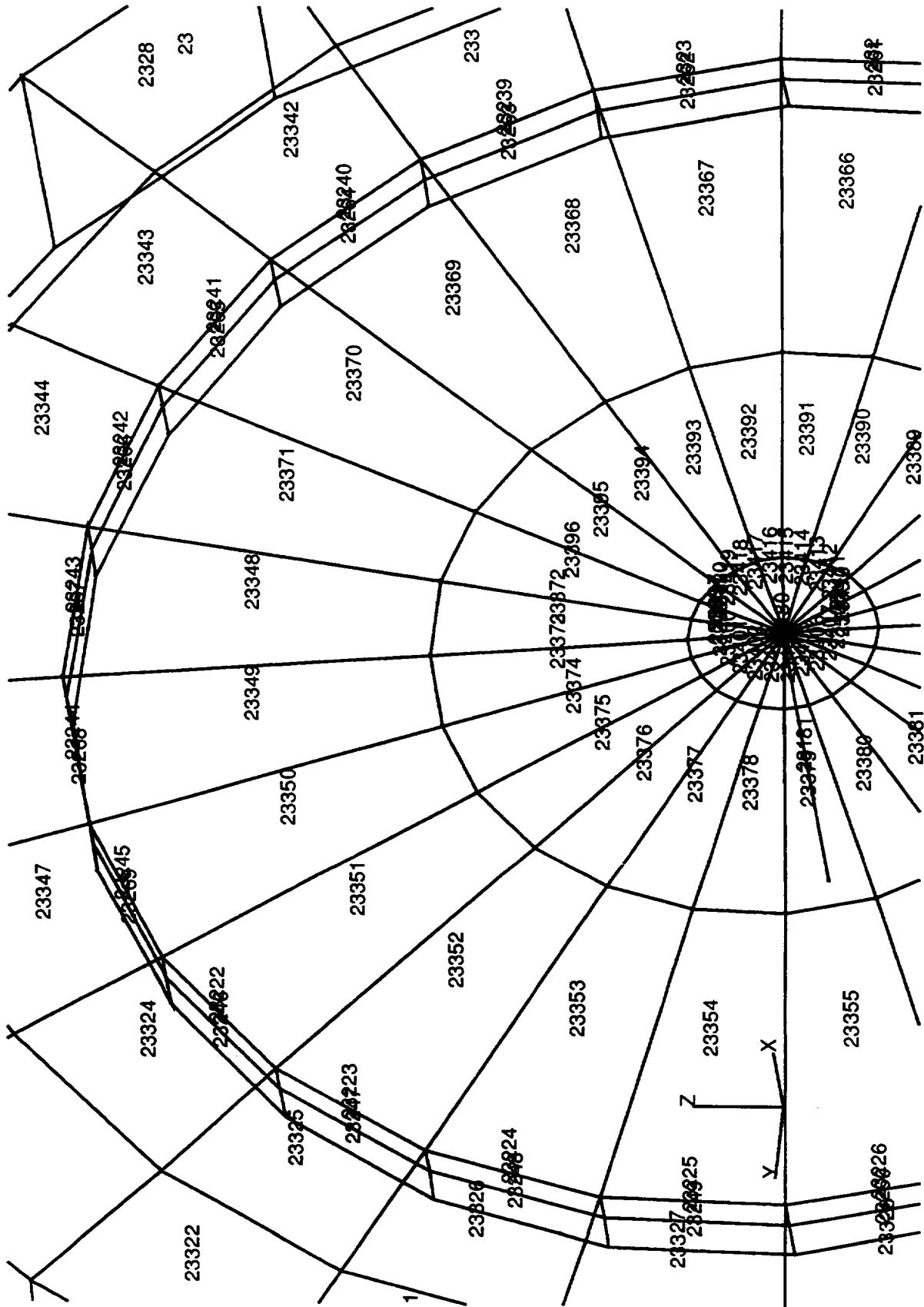


Figure A-48 Compensator Rotor Elements

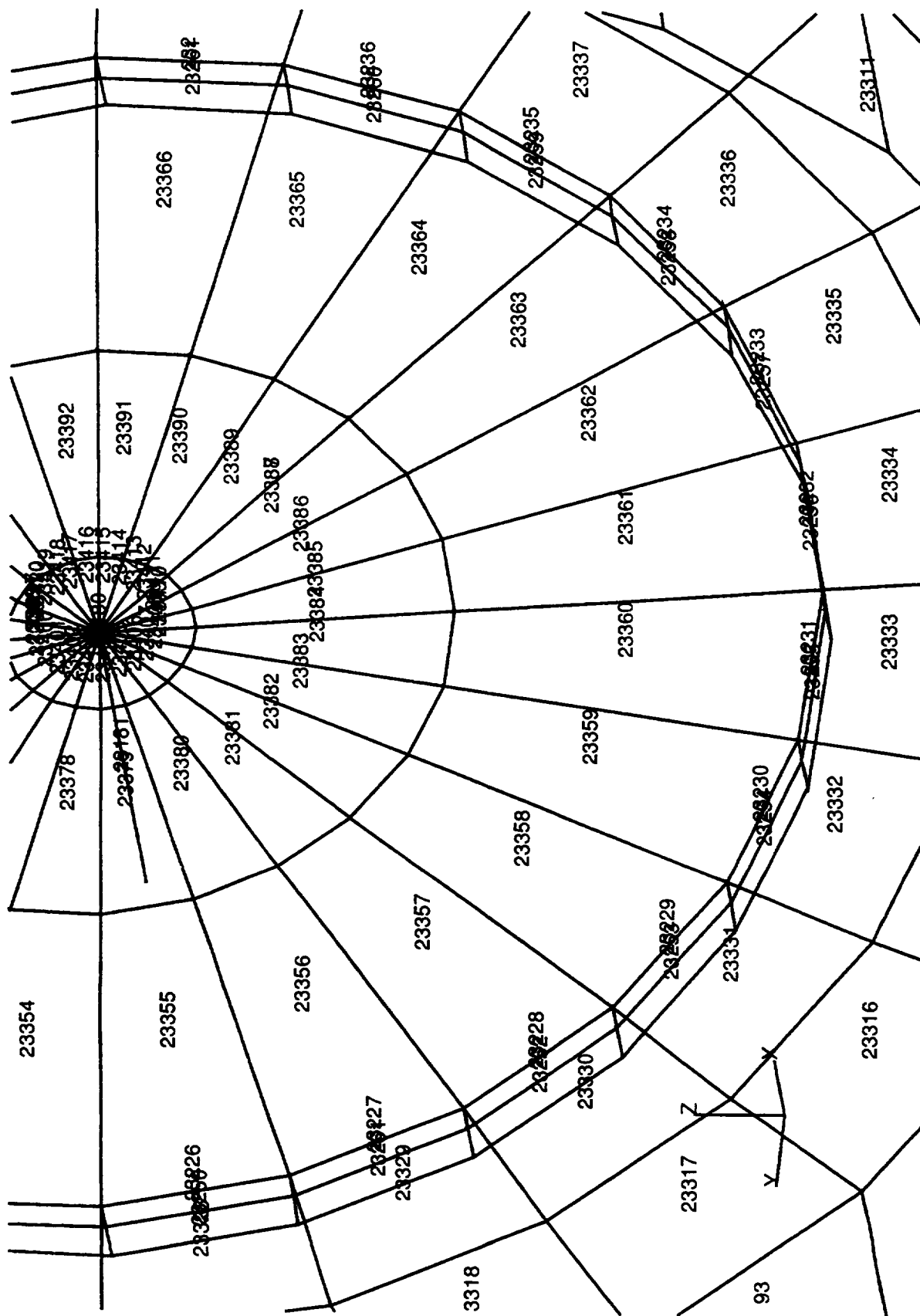


Figure A-49 Compensator Rotor Elements

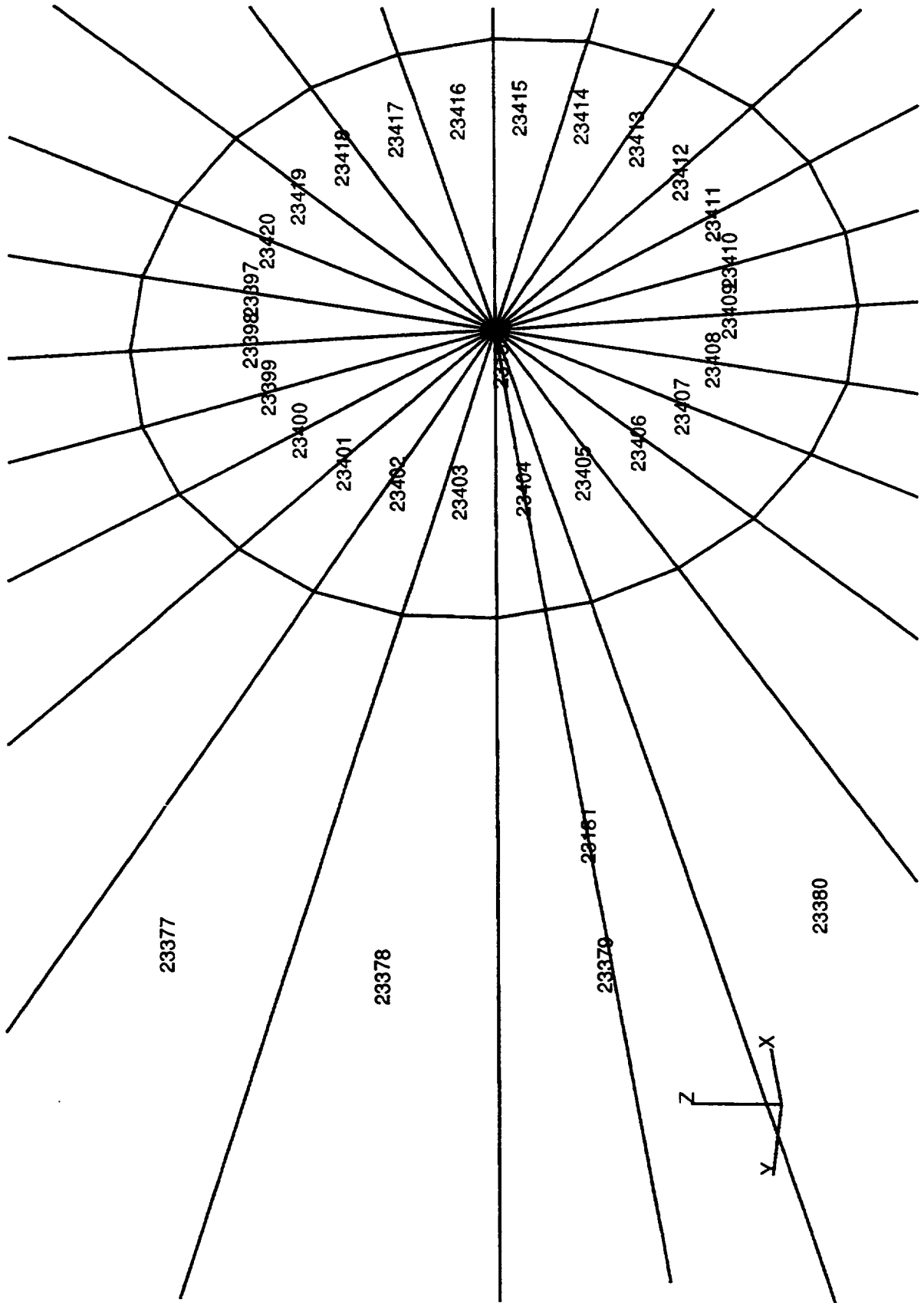


Figure A-50 Compensator Rotor Elements

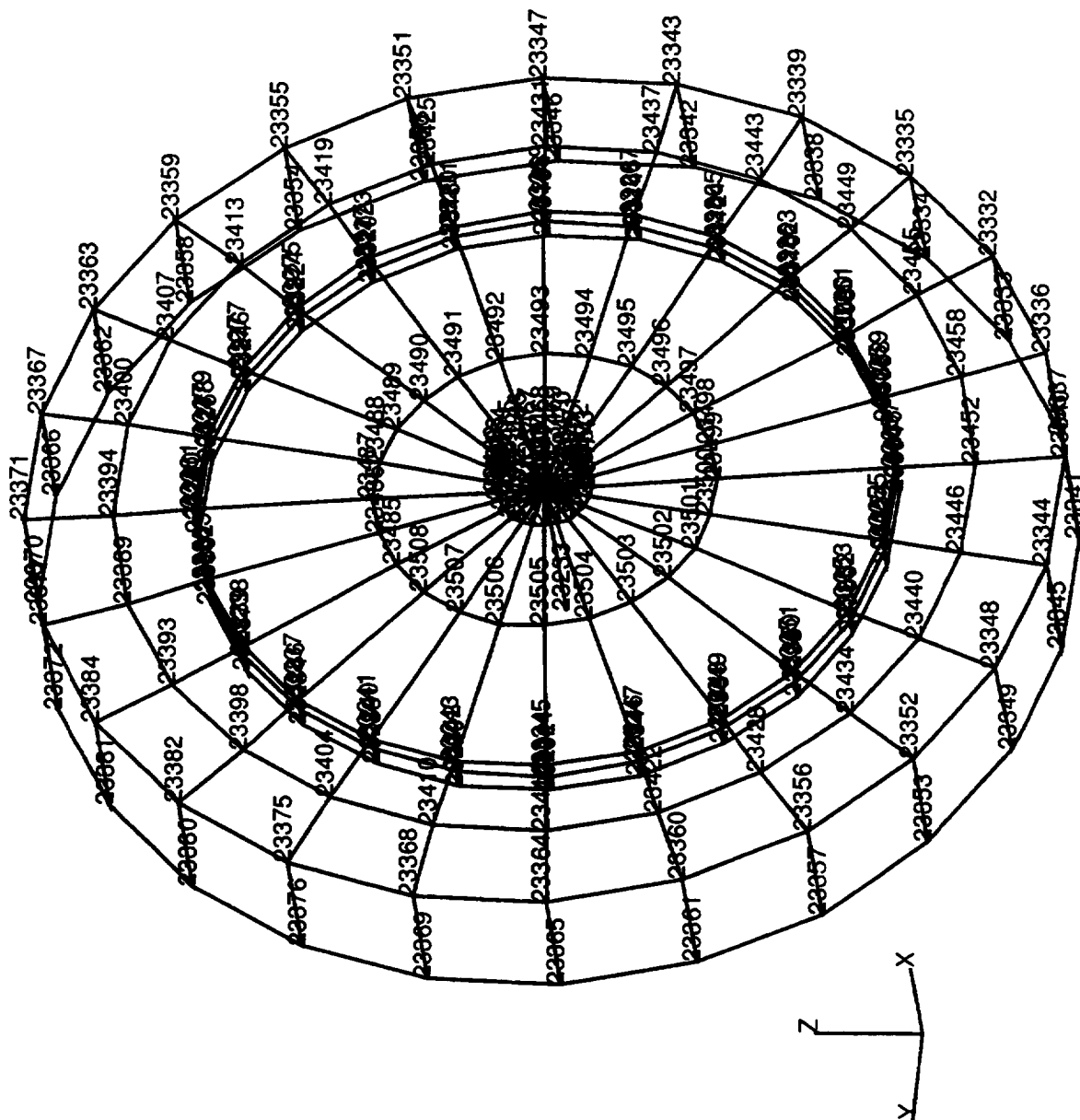


Figure A-51 Compensator Rotor Grid Points

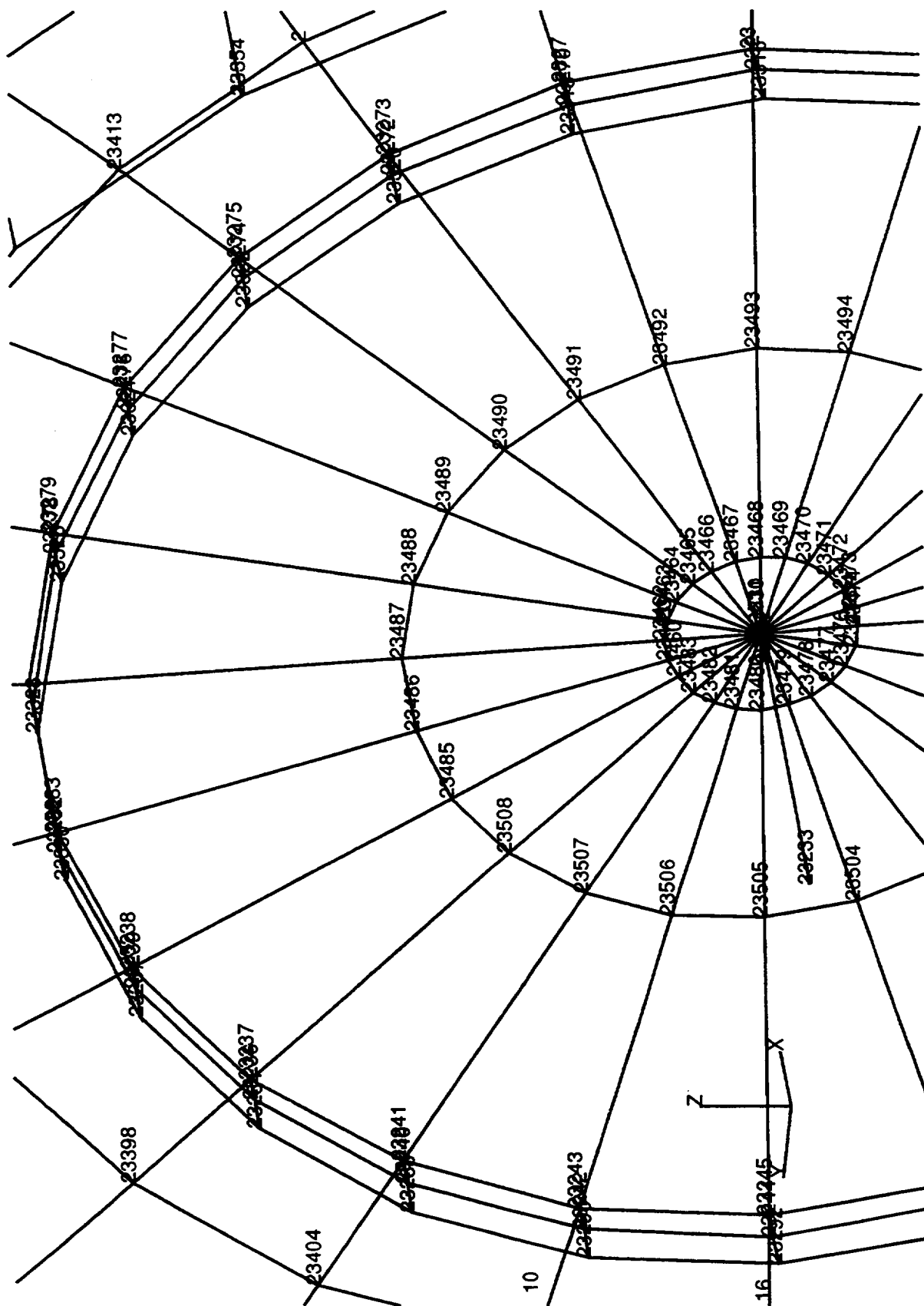


Figure A-52 Compensator Rotor Grid Points

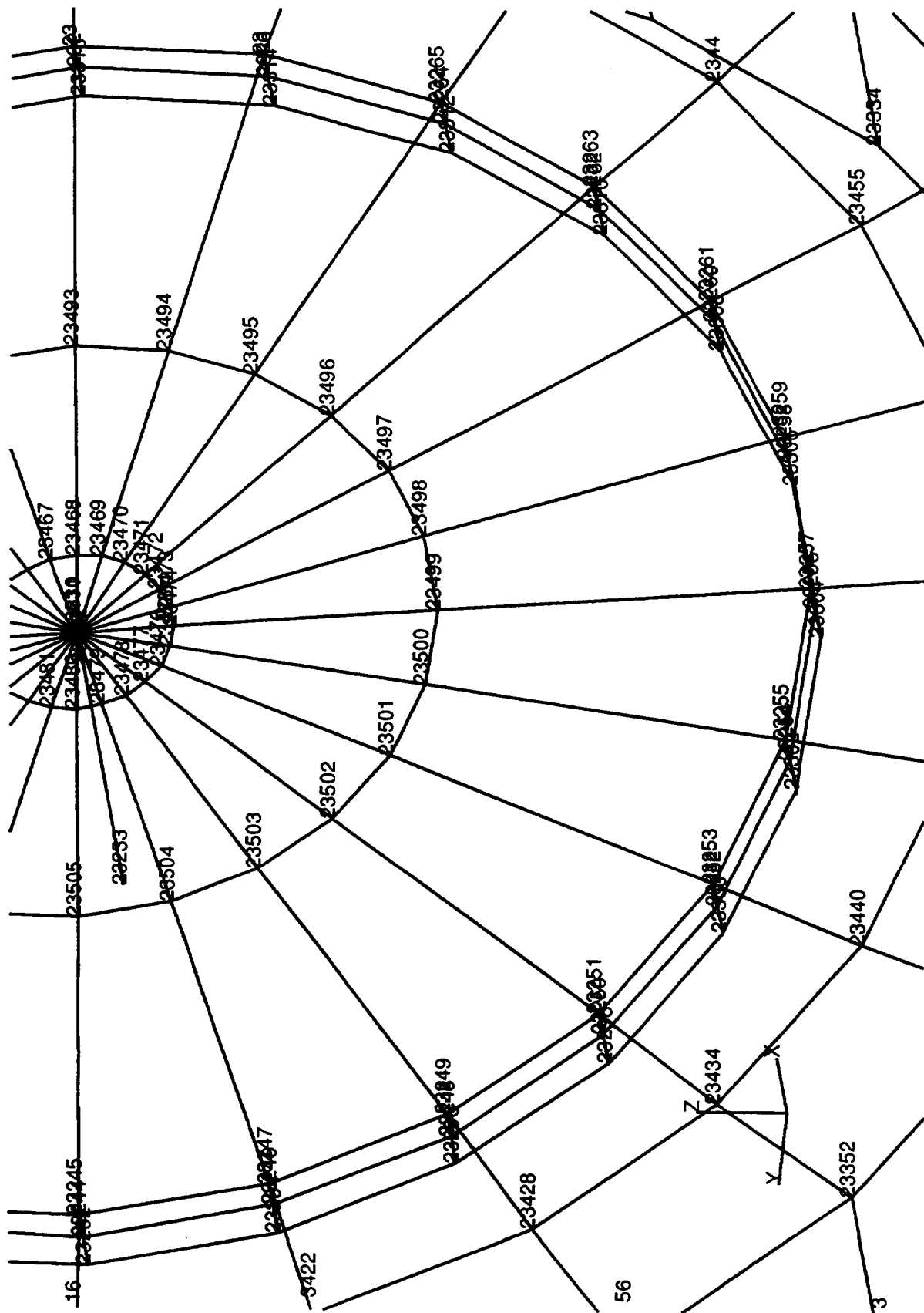


Figure A-53 Compensator Rotor Grid Points

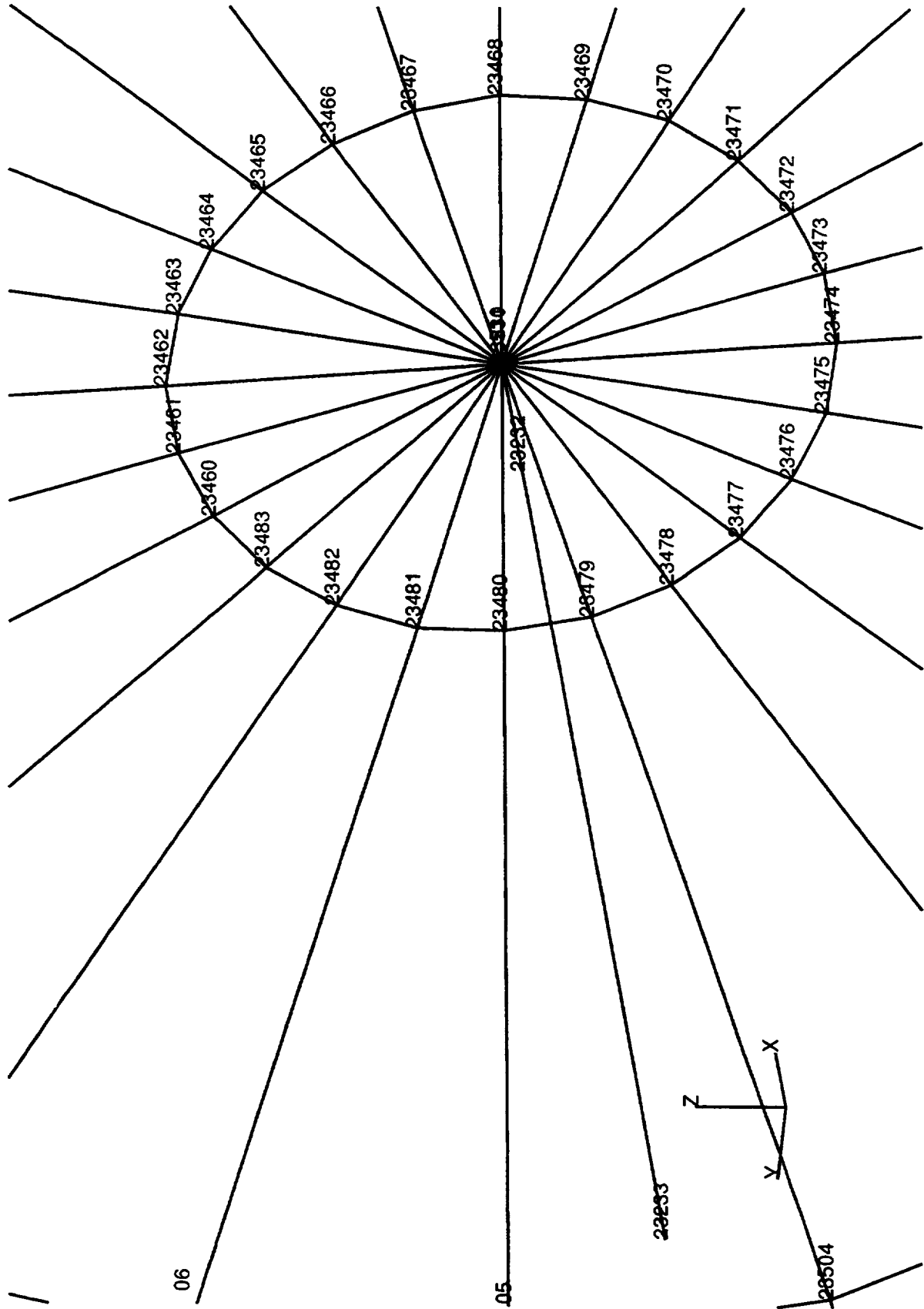


Figure A-54 Compensator Rotor Grid Points

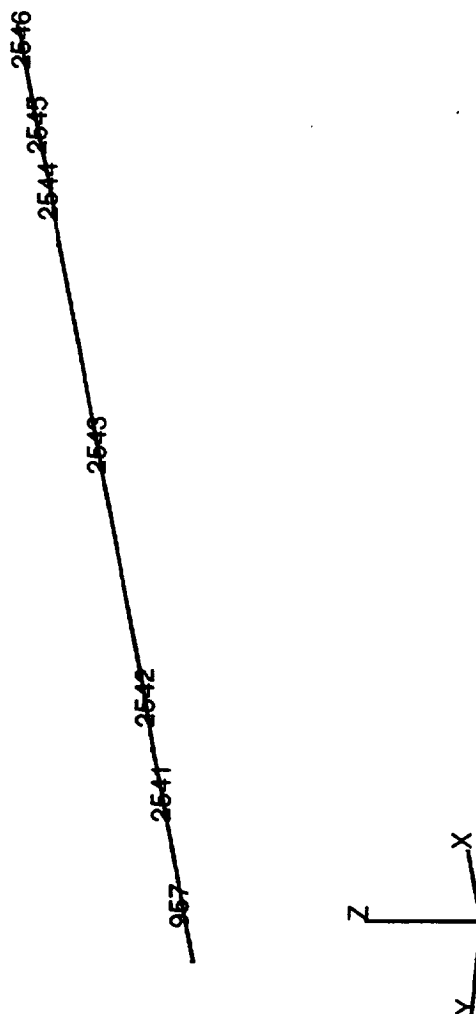


Figure A-55 Motor Shaft Elements

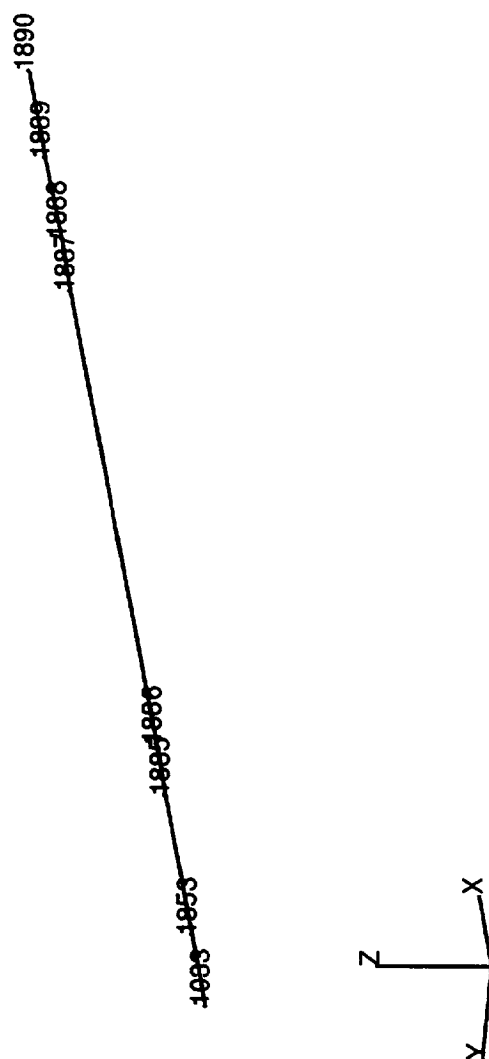


Figure A-56 Motor Shaft Grid Points



Figure A-57 Compensator Housing Elements

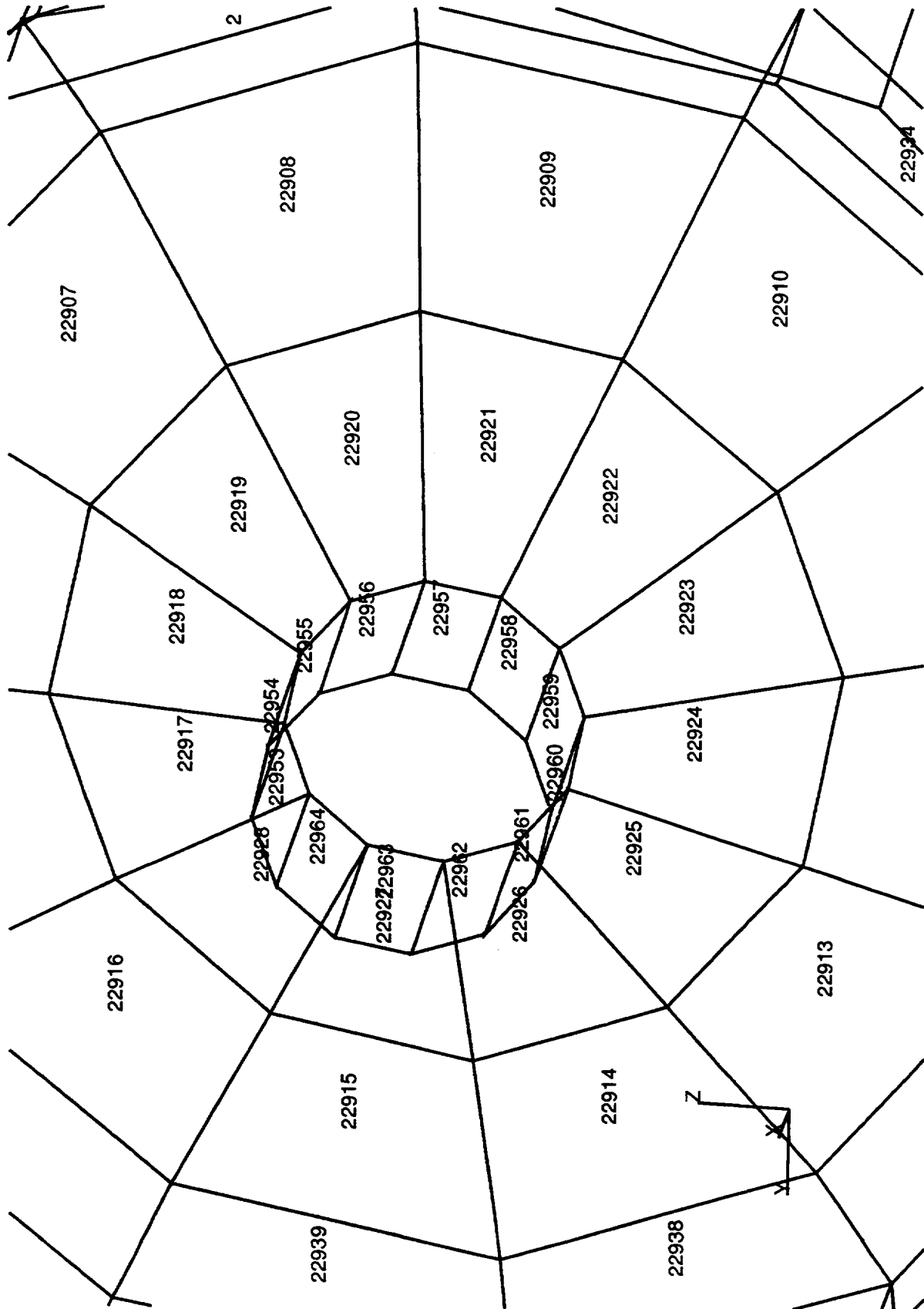


Figure A-58 Compensator Housing Elements

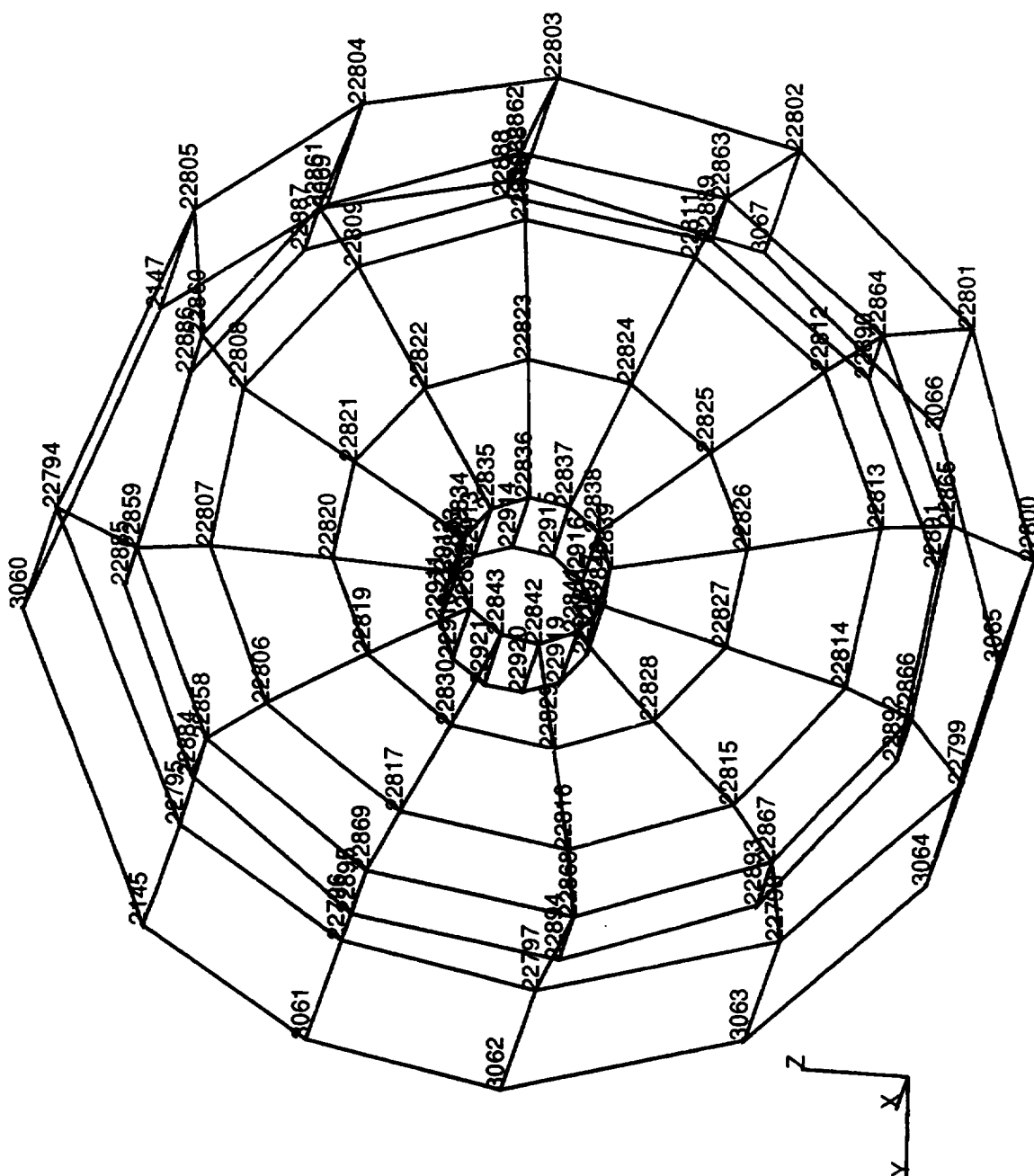


Figure A-59 Compensator Housing Grid Points

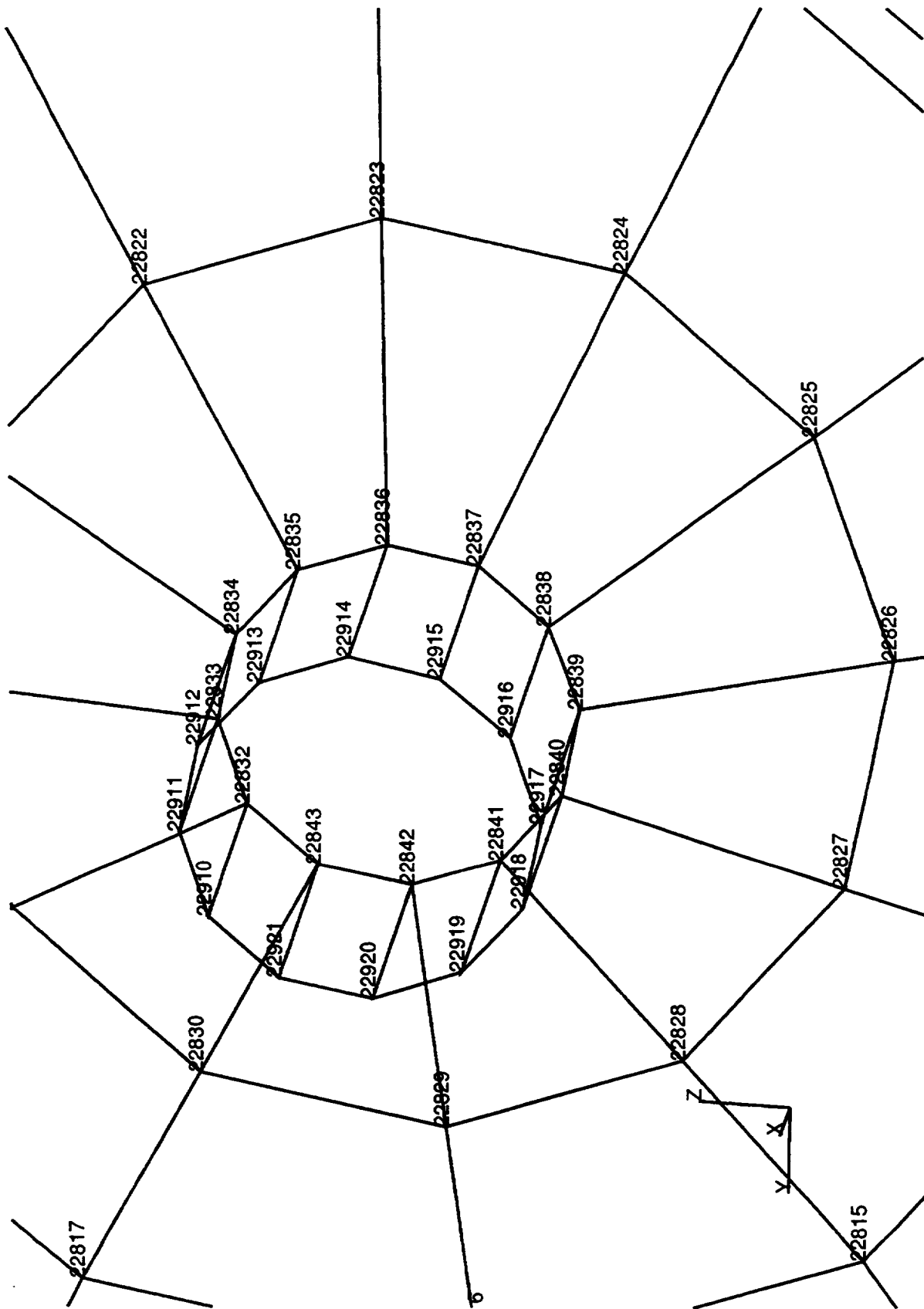


Figure A-60 Compensator Housing Grid Points

[illegible]

Figure A-61 Baseplate Elements

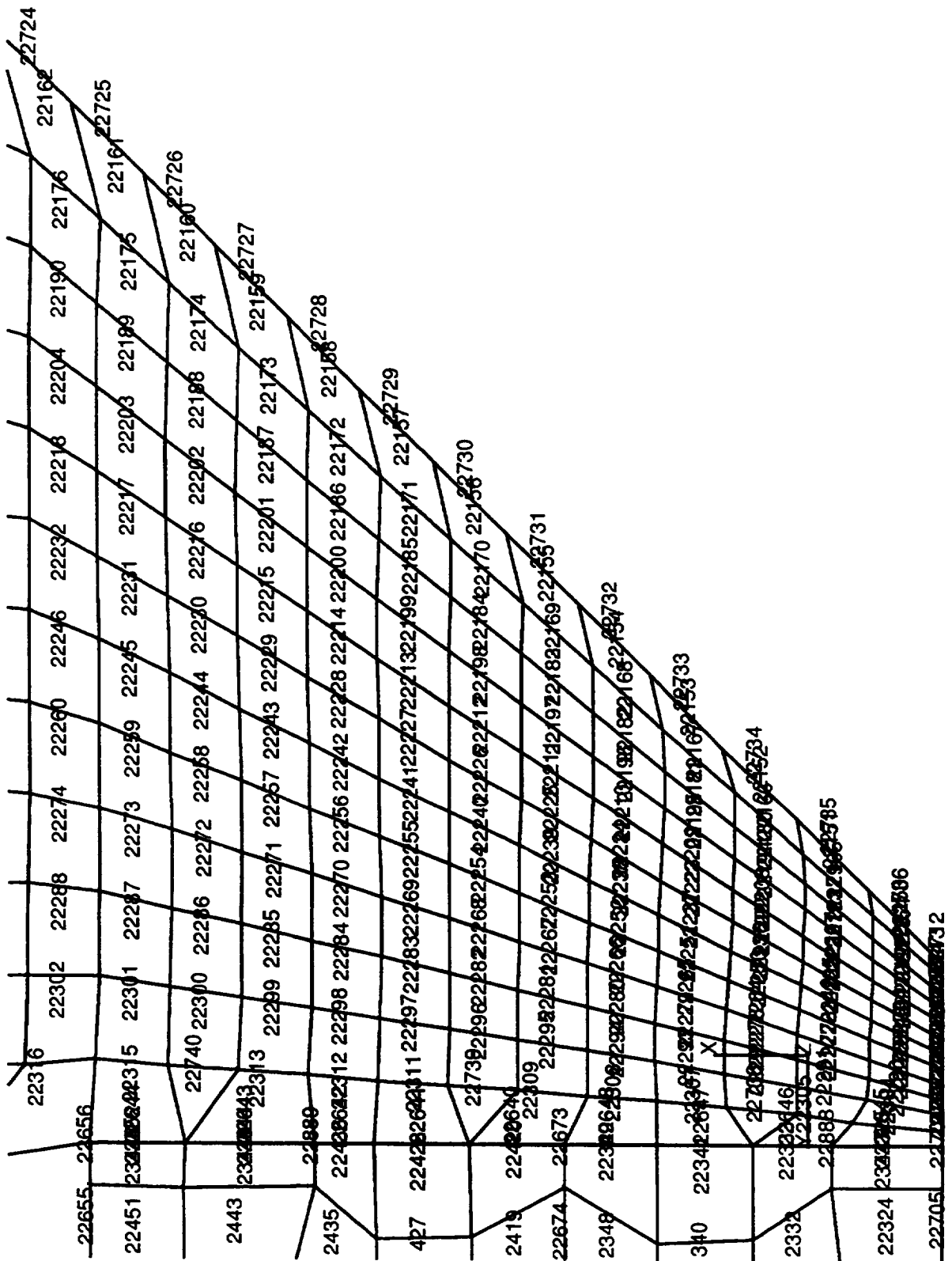


Figure A-62 Baseplate Elements

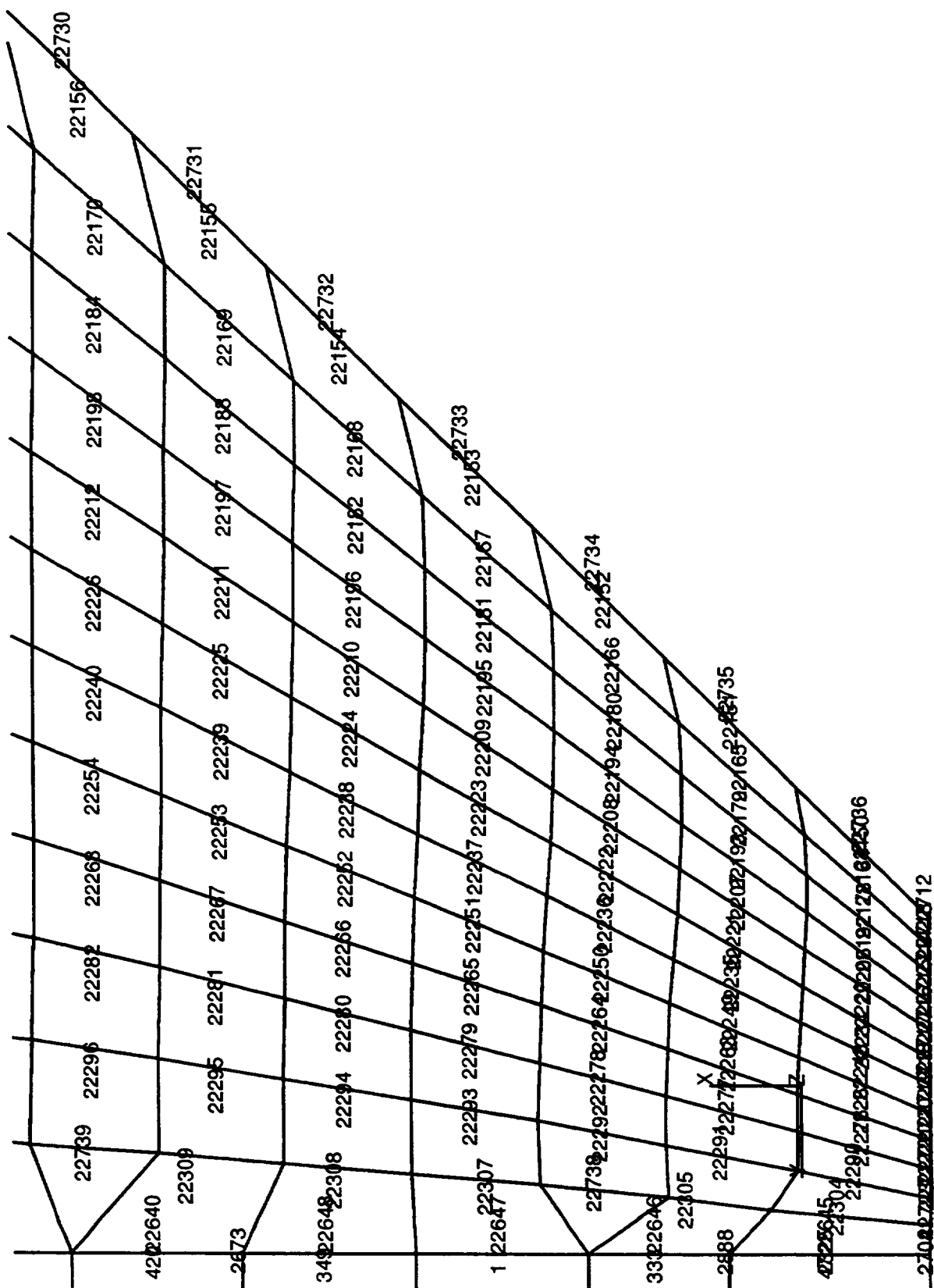
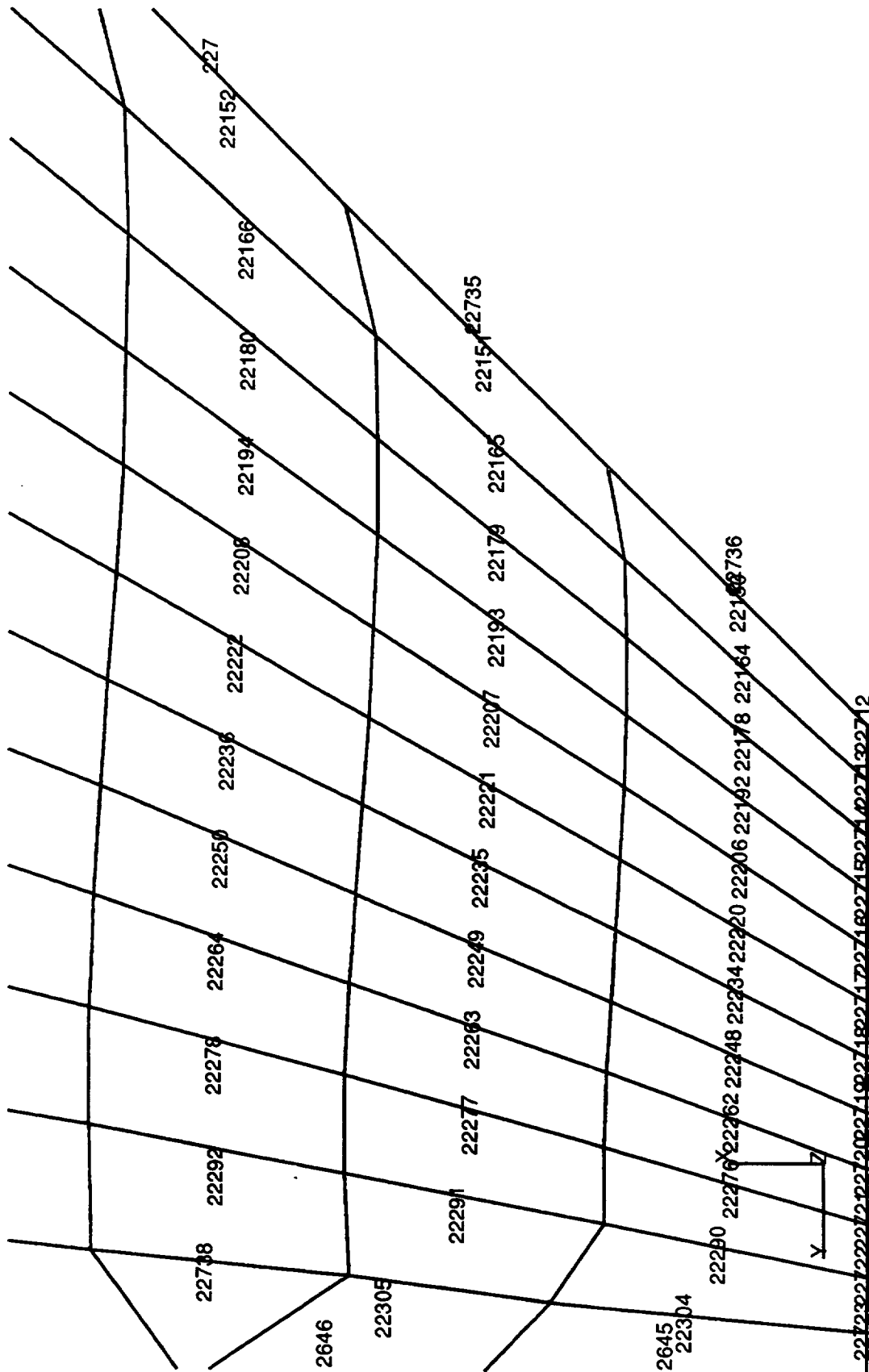


Figure A-63 Baseplate Elements



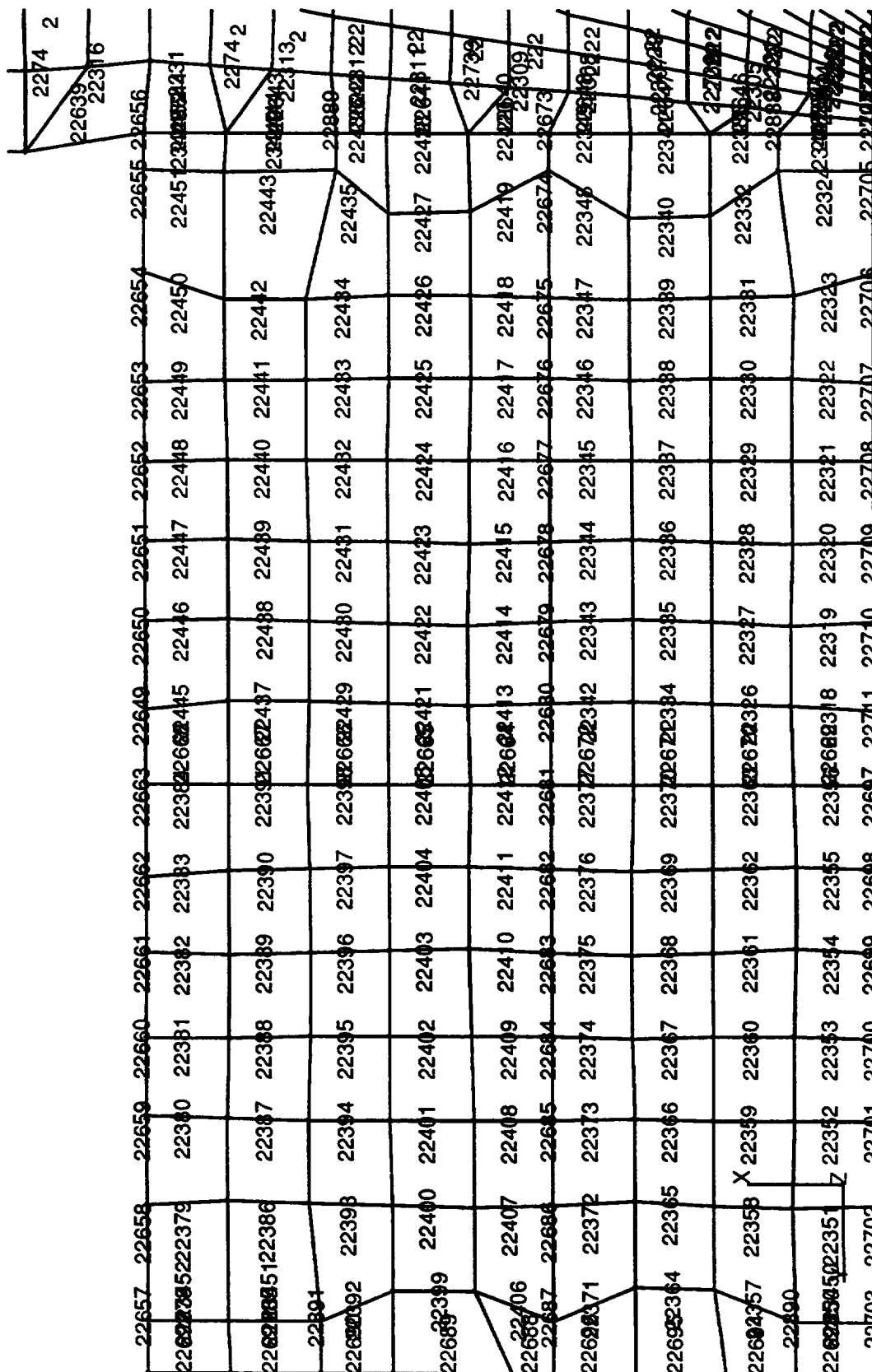


Figure A-65 Baseplate Elements

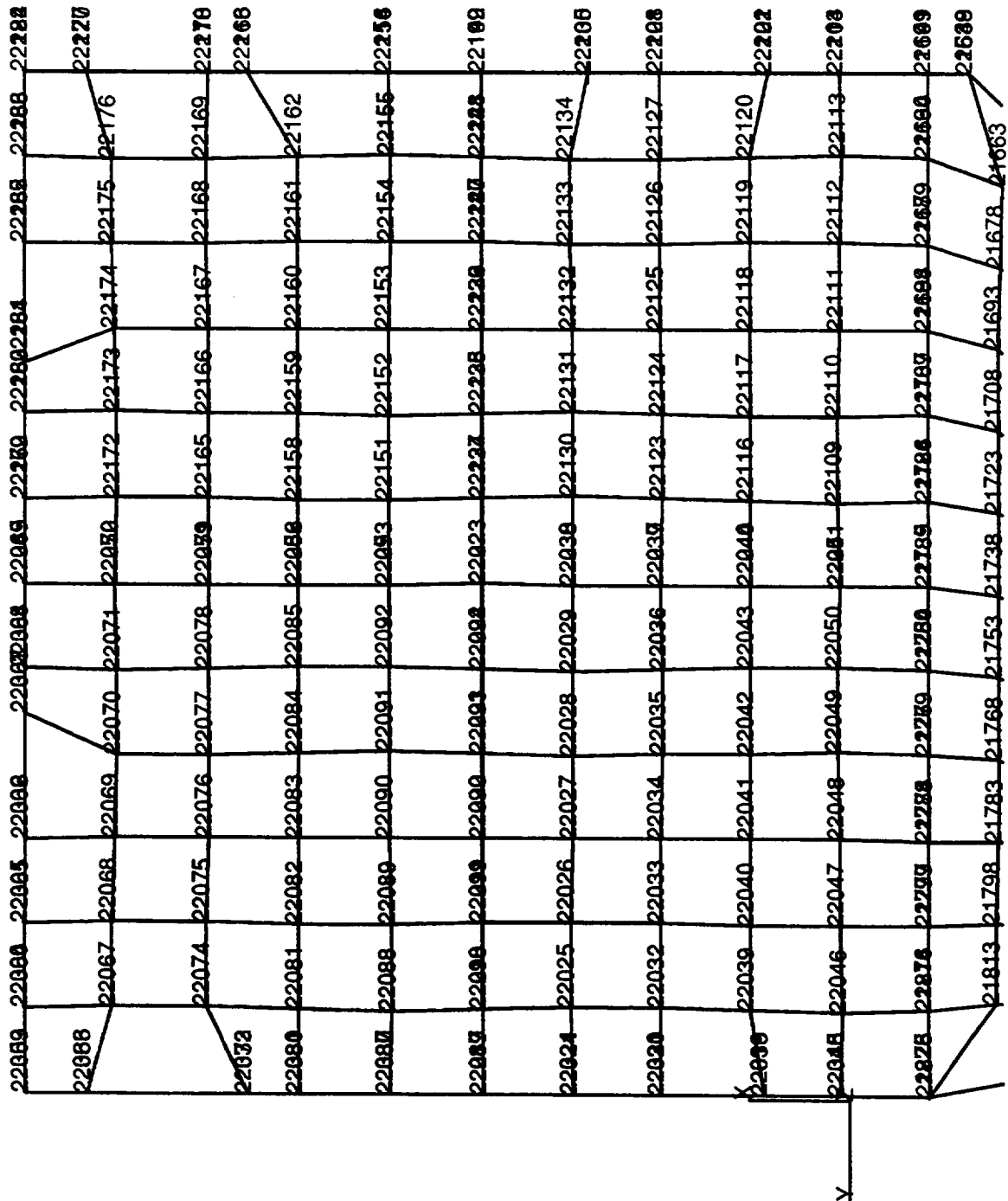


Figure A-66 Baseplate Grid Points



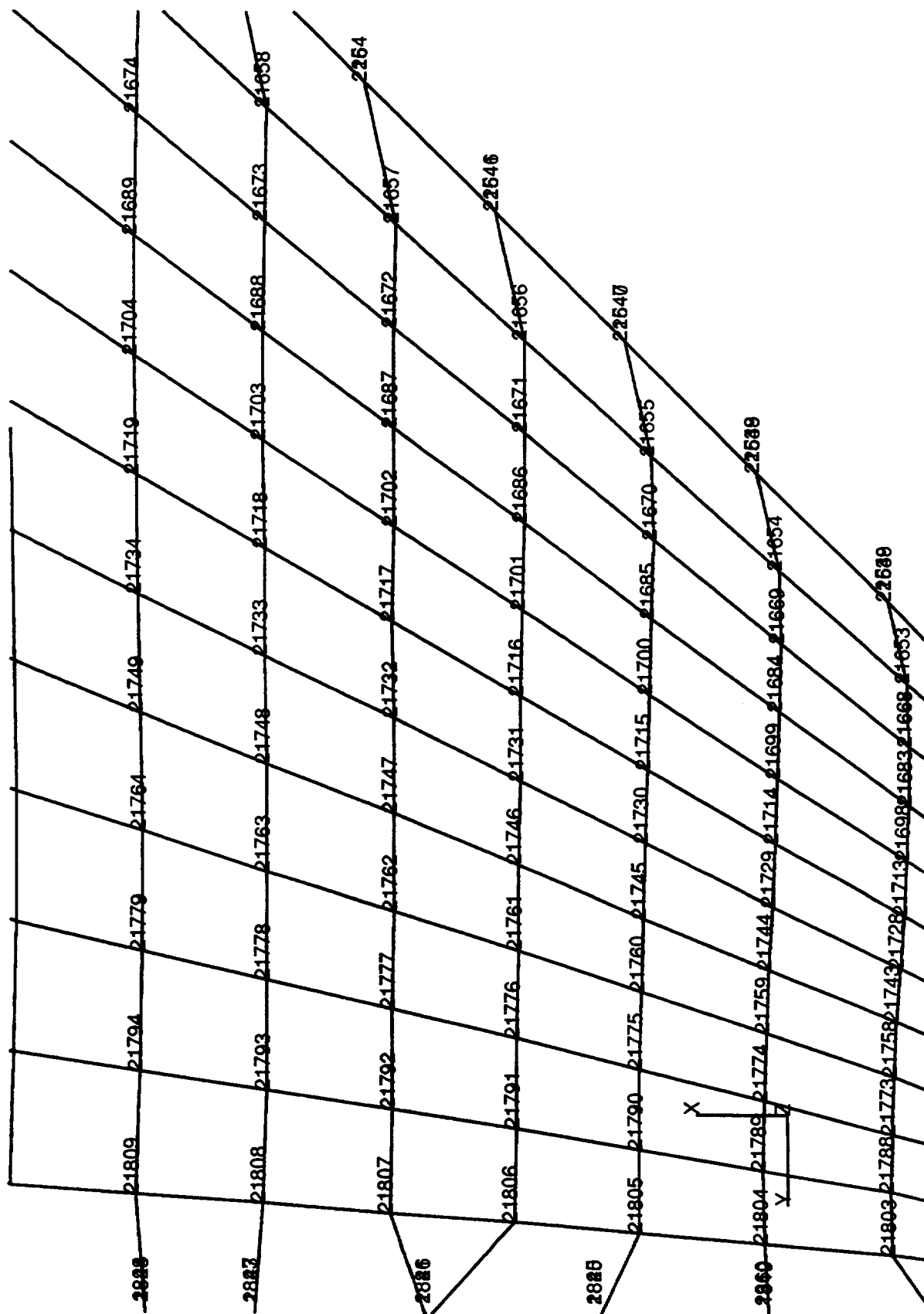


Figure A-68 Baseplate Grid Points

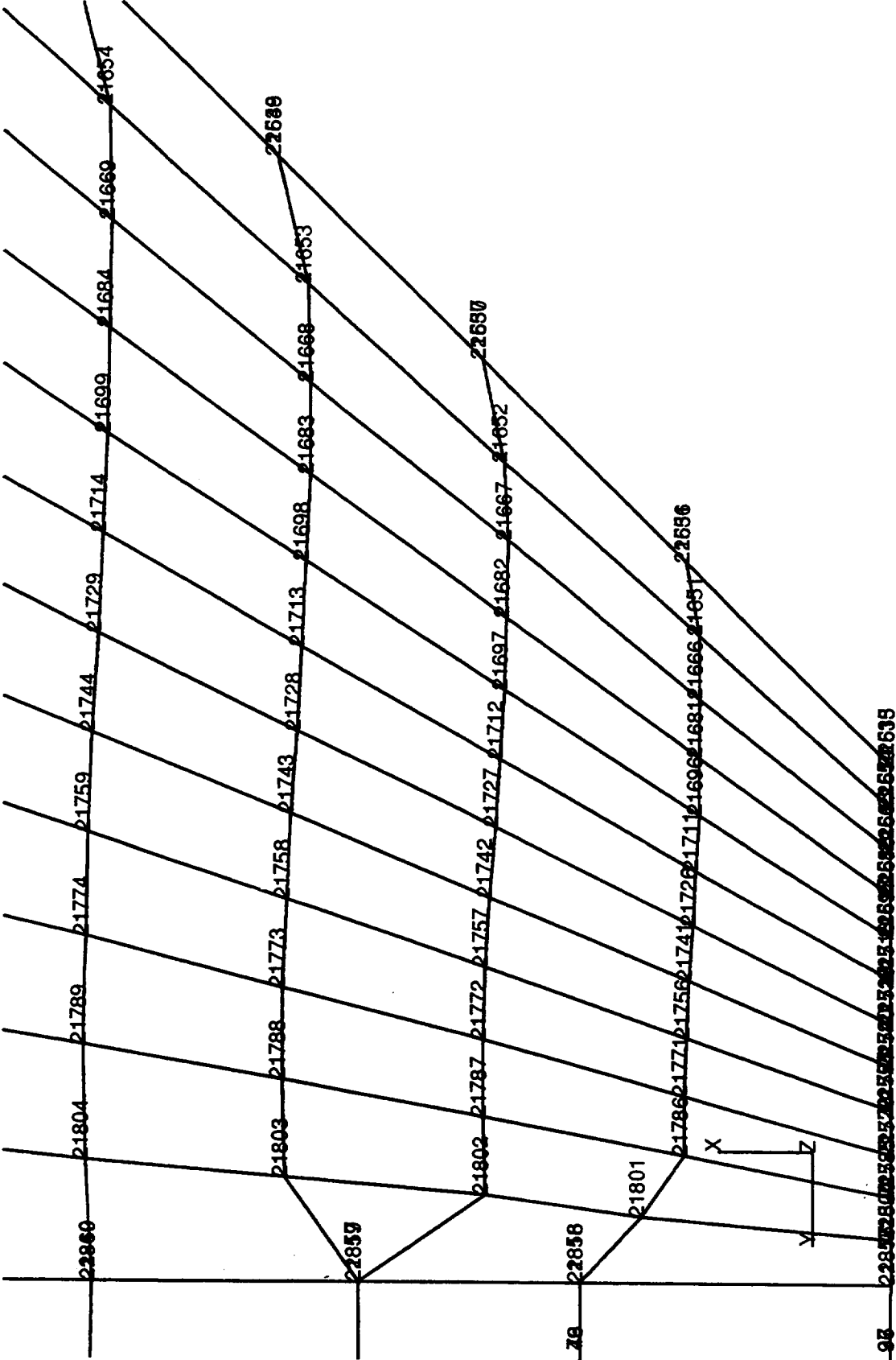


Figure A-69 Baseplate Grid Points

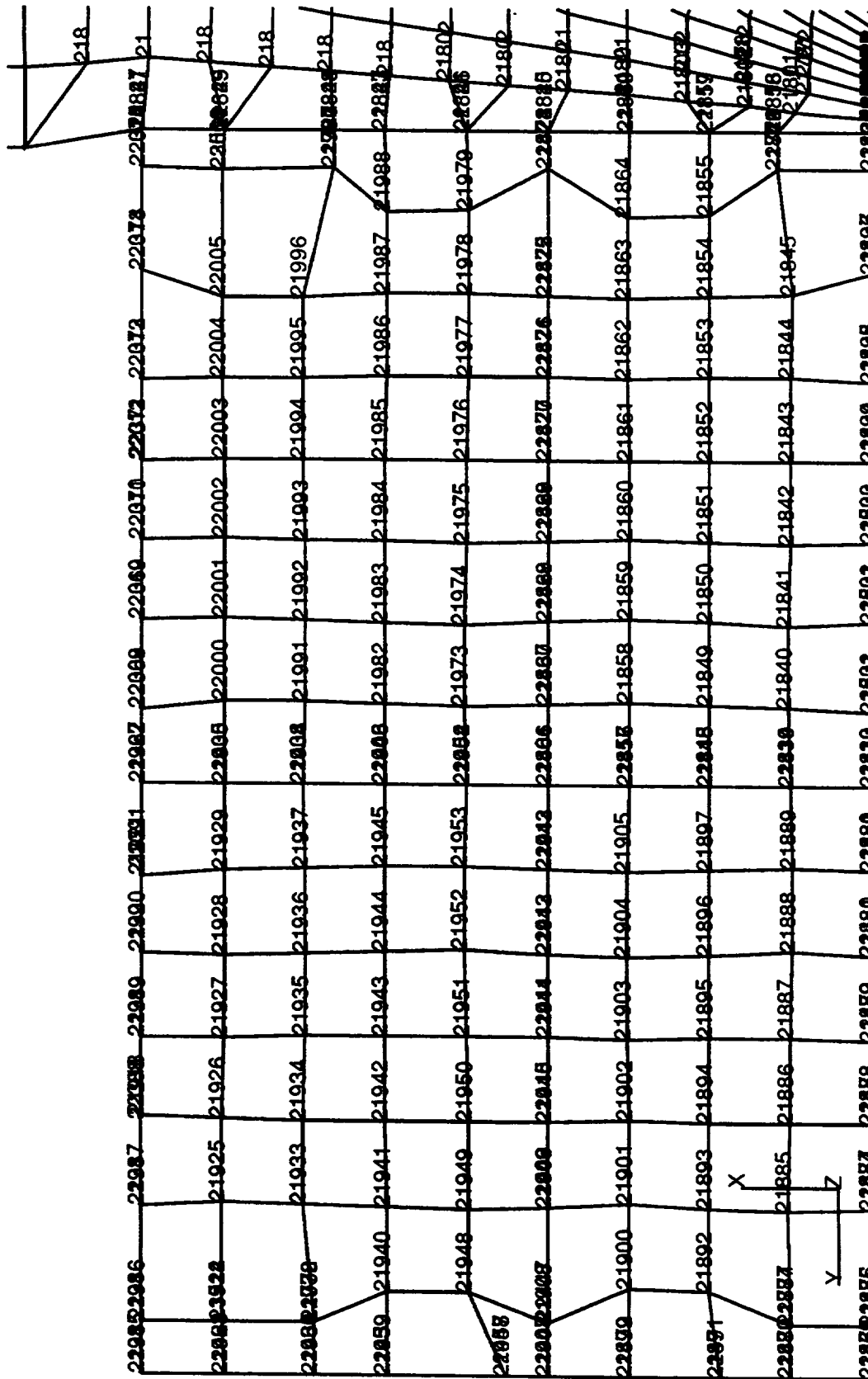


Figure A-70 Baseplate Grid Points

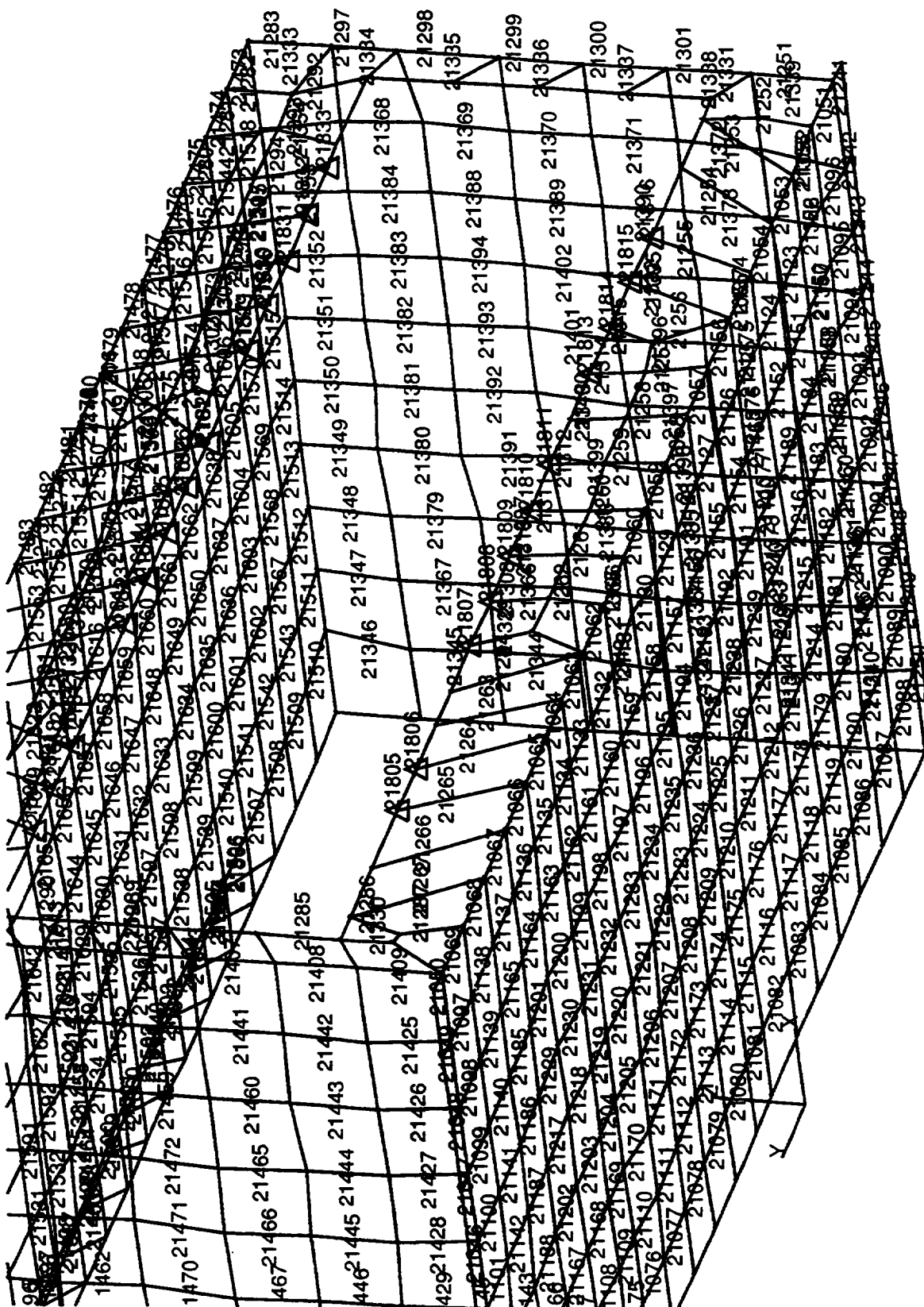


Figure A-71 Card Cage Elements



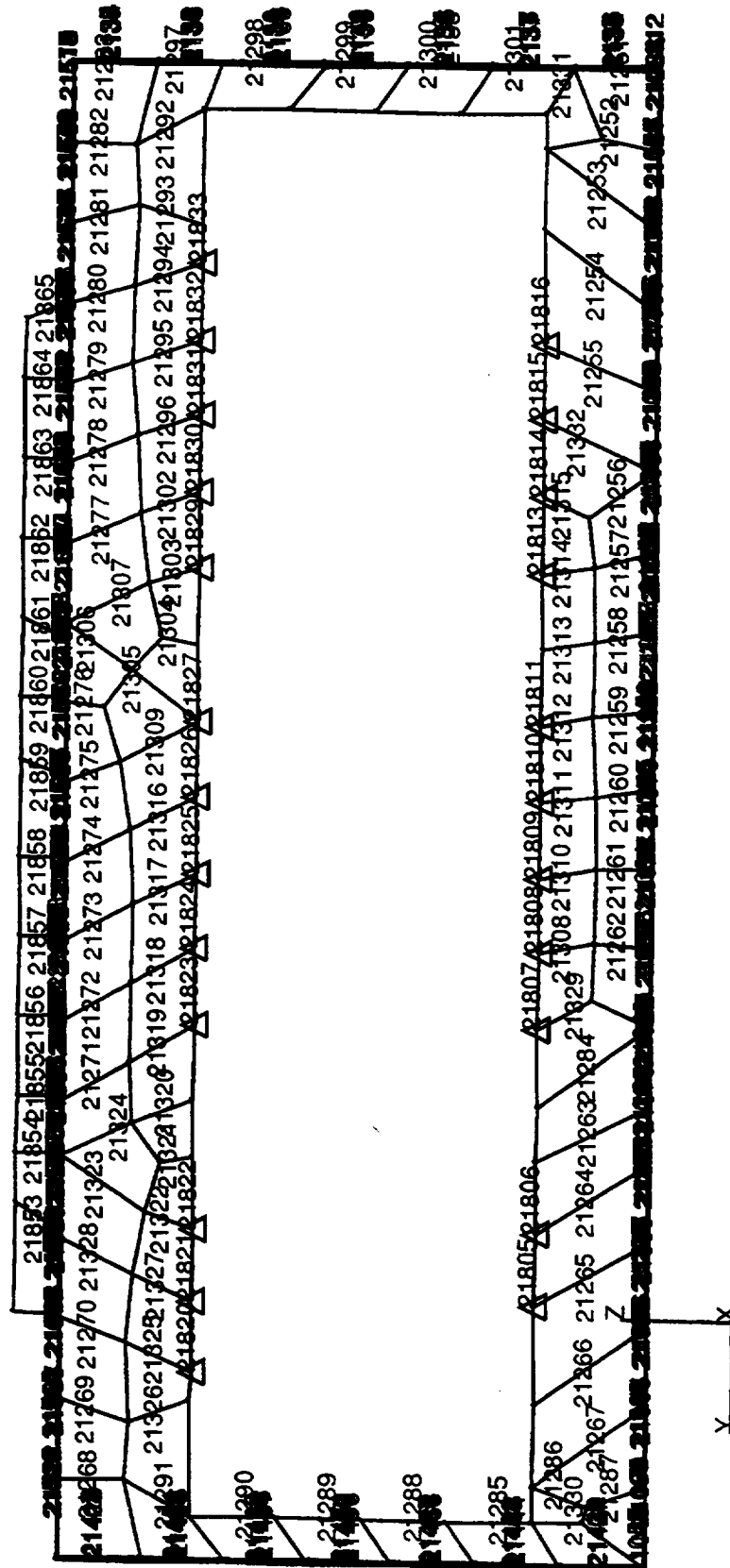


Figure A-73 Card Cage Elements

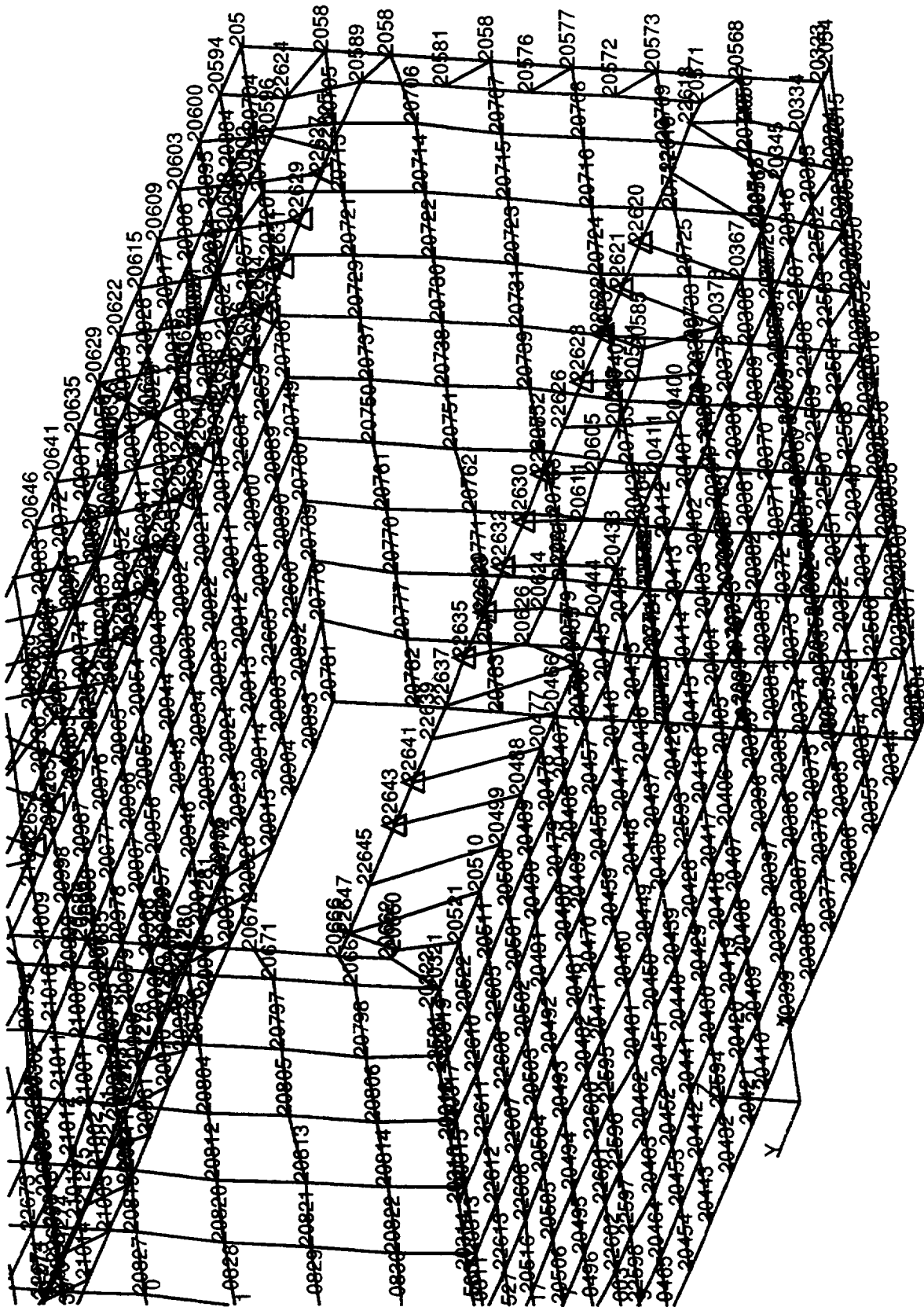


Figure A-74 Card Cage Grid Points

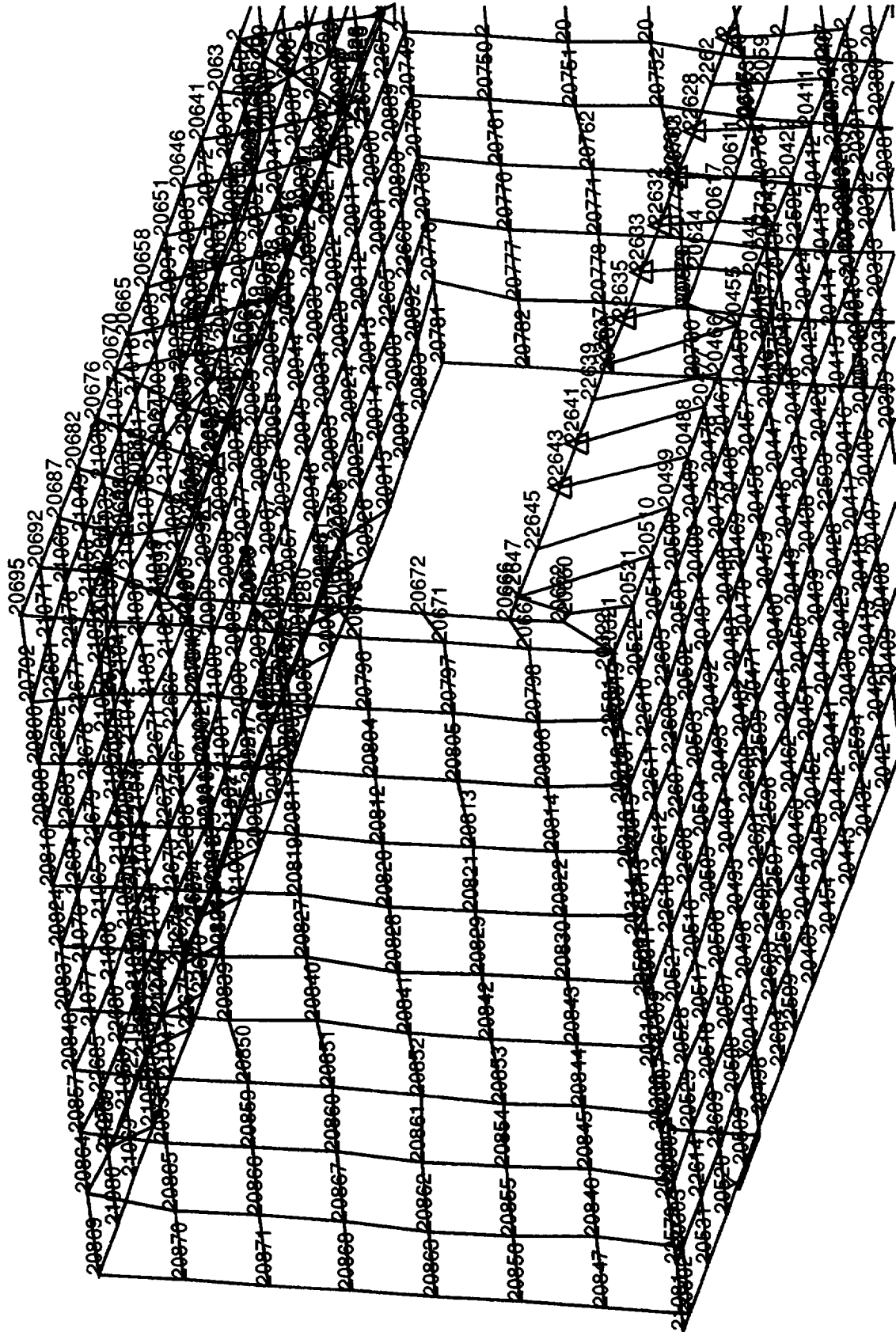


Figure A-75 Card Cage Grid Points

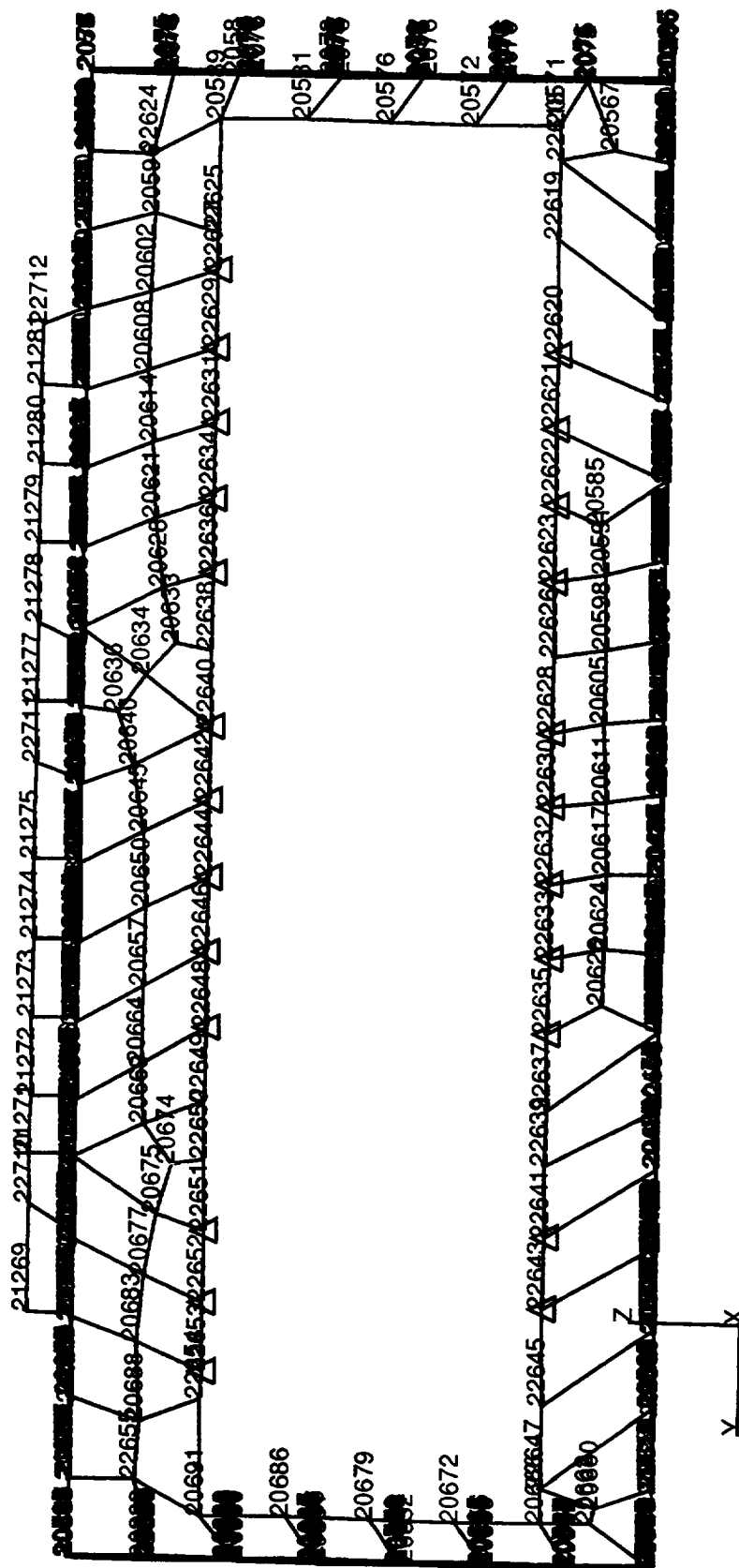


Figure A-76 Card Cage Grid Points

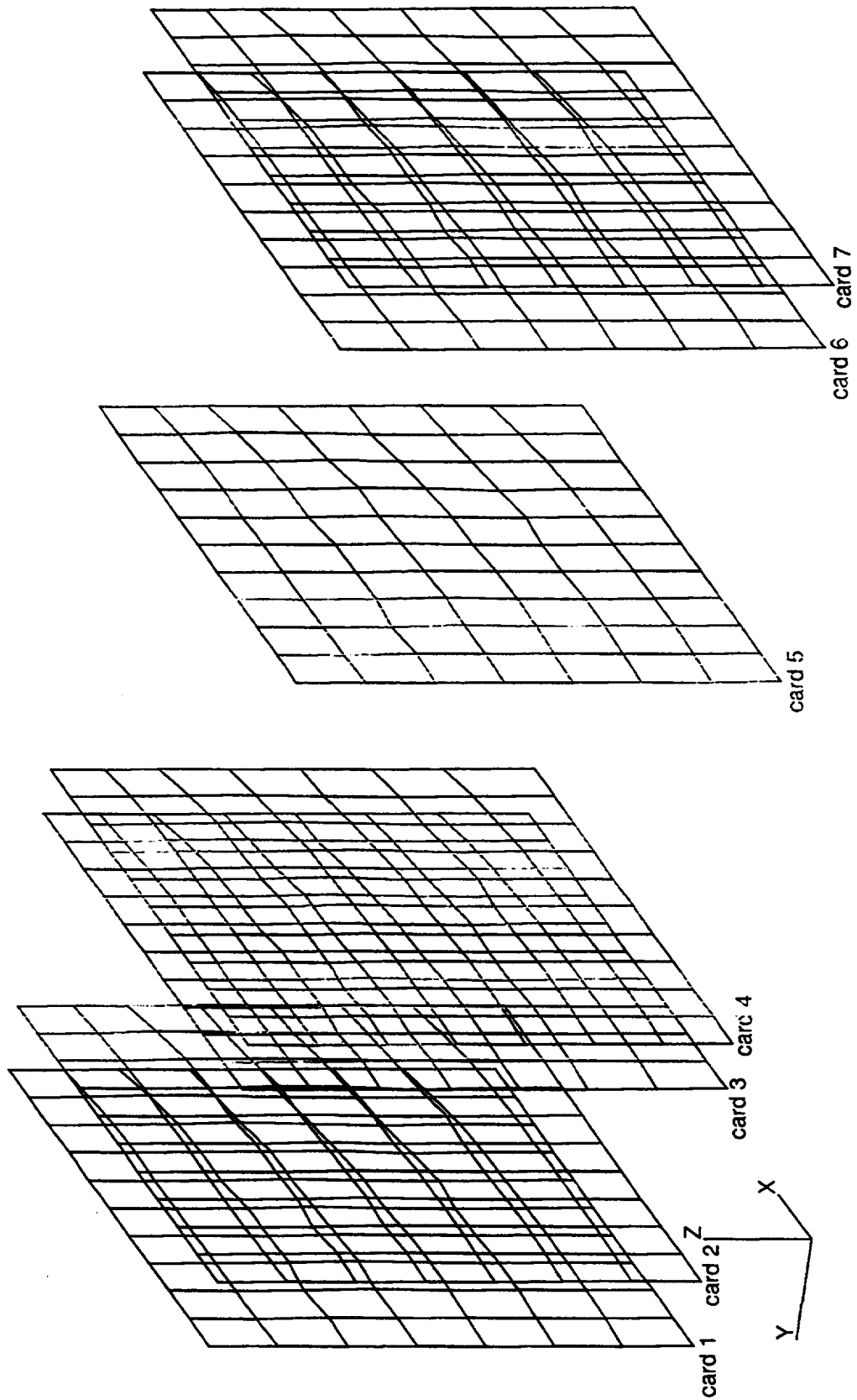


Figure A-77 Circuit Cards

Card 1

21423	21422	22735	21420	21419	22734	22732	22730	22728	21386	21378
22007	22006	22005	22004	22003	22002	22001	22000	21999	21997	21978
21434	21433	21432	21431	21430	21417	21409	21401	21393	21385	22726
21988	21989	21990	21991	21992	21993	21994	21995	21996	21998	21376
21443	21442	21441	21440	21429	21416	21408	21400	21392	21384	21978
21967	21983	21985	21984	21983	21982	21981	21980	21979	21383	21375
21450	21449	21448	21439	21428	21415	21407	21399	21391	21977	21374
21968	21969	21970	21971	21972	21973	21974	21975	21976	21382	21374
21455	21454	21447	21438	21427	21414	21406	21398	21390	21958	21373
21967	21966	21965	21964	21963	21962	21961	21960	21959	21381	21373
21458	21453	21446	21437	21426	21413	21405	21397	21389	21957	22725
21948	21949	21950	21951	21952	21953	21954	21955	21956	21380	22725
21457	21452	21445	21436	21425	21412	21404	21396	21388	21939	21938
21947	21946	21945	21944	21943	21942	21941	21940	21939	21938	21938
21456	22736	21444	21435	21424	22733	22731	22729	22727	21379	21371

Figure A-78 Circuit Card 1 Elements and Grid Points

Card 2

21335	21334	22723	21332	21331	22722	22720	22718	22716	21298	21290
21937	21936	21935	21934	21933	21932	21931	21930	21929	21927	
21346	21345	21344	21343	21342	21329	21321	21313	21305	21297	21289
21918	21919	21920	21921	21922	21923	21924	21925	21926	21928	
21355	21354	21353	21352	21341	21328	21320	21312	21304	21296	22714
21917	21916	21915	21914	21913	21912	21911	21910	21909	21908	
21362	21361	21360	21351	21340	21327	21319	21311	21303	21295	21287
21898	21899	21900	21901	21902	21903	21904	21905	21906	21907	
21367	21366	21359	21350	21339	21326	21318	21310	21302	21294	21286
21897	21896	21895	21894	21893	21892	21891	21890	21889	21888	
21370	21365	21358	21349	21338	21325	21317	21309	21301	21293	21285
21878	21879	21880	21881	21882	21883	21884	21885	21886	21887	
21369	21364	21357	21348	21337	21324	21316	21308	21300	21292	22713
21877	X-21876	21875	21874	21873	21872	21871	21870	21869	21868	
21368	22724	21356	21347	21336	22721	22719	22717	22715	21291	21283

Figure A-79 Circuit Card 2 Elements and Grid Points

Card 3

22692	22691	22690	22689	22688	21129	21121	21113	21105	21097	21089
21679	21680	21681	21682	21683	21684	21685	21686	21687	21673	21673
21145	21144	21143	21142	21141	21128	21120	21112	21104	21096	21088
21692	21698	21699	21700	21701	21702	21703	21704	21693	21674	22687
21154	21153	21152	21151	21140	21127	21119	21111	21103	21095	22687
21691	21717	21723	21724	21725	21726	21727	21712	21694	21675	21086
21161	21160	21159	21150	21139	21126	21118	21110	21102	21094	21086
21690	21716	21728	21729	21730	21731	21732	21713	21695	21676	21085
21166	21165	21158	21149	21138	21125	21117	21109	21101	21093	21085
21689	21715	21722	21721	21720	21719	21718	21714	21696	21677	21084
21169	21164	21157	21148	21137	21124	21116	21108	21100	21092	21084
21688	21711	21710	21709	21708	21707	21706	21705	21697	21678	22686
21168	21163	21156	21147	21136	21123	21115	21107	21099	21091	22686
21672	X ₂ 21671	21670	21669	21668	21667	21666	21665	21664	21663	
22697	22696	22695	22694	22693	21122	21114	21106	21098	21090	21082

Figure A-80 Circuit Card 3 Elements and Grid Points

Card 4

22704	22703	22702	22701	22700	21217	21209	21201	21193	21185	21177
21749	21750	21751	21752	21753	21754	21755	21756	21757	21743	21743
21233	21232	21231	21230	21229	21216	21208	21200	21192	21184	21176
21762	21768	21769	21770	21771	21772	21773	21774	21763	21744	22699
21242	21241	21240	21239	21228	21215	21207	21199	21191	21183	21174
21761	21787	21793	21794	21795	21796	21797	21782	21764	21745	21174
21249	21248	21247	21238	21227	21214	21206	21198	21190	21182	21746
21760	21786	21798	21799	21800	21801	21802	21783	21765	21746	21173
21254	21253	21246	21237	21226	21213	21205	21197	21189	21181	21173
21759	21785	21792	21791	21790	21789	21788	21784	21766	21747	21172
21257	21252	21245	21236	21225	21212	21204	21196	21188	21180	21172
21758	21781	21780	21779	21778	21777	21776	21775	21767	21748	22698
21256	21251	21244	21235	21224	21211	21203	21195	21187	21179	21170
21742	21741	21740	21739	21738	21737	21736	21735	21734	21733	
22709	22708	22707	22706	22705	21210	21202	21194	21186	21178	21170

Figure A-81 Circuit Card 4 Elements and Grid Points

Card 5

23603	23602	23601	23600	23599	23598	23550	23542	23534	23526
23482	23483	23484	23485	23486	23487	23488	23489	23490	23476
23576	23575	23574	23573	23572	23565	23557	23549	23541	23533
23495	23501	23502	23503	23504	23505	23506	23507	23496	23477
23584	23583	23582	23581	23571	23564	23556	23548	23540	23532
23494	23520	23526	23527	23528	23529	23530	23515	23497	23478
23590	23589	23588	23580	23570	23563	23555	23547	23539	23531
23493	23519	23531	23532	23533	23534	23535	23516	23498	23479
23594	23593	23587	23579	23569	23562	23554	23546	23538	23530
23492	23518	23525	23524	23523	23522	23521	23517	23499	23480
23596	23592	23586	23578	23568	23561	23553	23545	23537	23529
23491	23514	23513	23512	23511	23510	23509	23508	23500	23481
23595	23591	23585	23577	23567	23560	23552	23544	23536	23528
23475	23474	23473	23472	23471	23470	23469	23468	23467	23466
23608	23607	23606	23605	23604	23559	23551	23543	23535	23527

Figure A-82 Circuit Card 5 Elements and Grid Points

Card 6

21511	21510	22747	21508	21507	22746	22744	22742	22740	21474	21466
22077	22076	22075	22074	22073	22072	22071	22070	22069	22067	21465
21522	21521	21520	21519	21518	21505	21497	21489	21481	21473	22068
22058	22059	22060	22061	22062	22063	22064	22065	22066	22068	22738
21531	21530	21529	21528	21517	21504	21496	21488	21480	21472	22048
22057	22056	22055	22054	22053	22052	22051	22050	22049	21471	21463
21538	21537	21536	21527	21516	21503	21495	21487	21479	22047	21462
22038	22039	22040	22041	22042	22043	22044	22045	22046	21470	22028
21543	21542	21535	21526	21515	21502	21494	21486	21478	21469	21461
22037	22036	22035	22034	22033	22032	22031	22030	22029	22027	22737
21546	21541	21534	21525	21514	21501	21493	21485	21477	21468	22008
22018	22019	22020	22021	22022	22023	22024	22025	22026	22009	21459
21545	21540	21533	21524	21513	21500	21492	21484	21476	22008	
22017	22016	22015	22014	22013	22012	22011	22010	22009	22008	
21544	21539	22748	21523	21512	22745	22743	22741	22739	21467	

Figure A-83 Circuit Card 6 Elements and Grid Points

Card 7

21599	21598	22759	21596	21595	22753	22756	22754	22752	21562	21554
22147	22146	22145	22144	22143	22142	22141	22140	22139	22137	22750
21610	21609	21608	21607	21606	21593	21585	21577	21569	21561	21552
22128	22129	22130	22131	22132	22133	22134	22135	22136	22138	21552
21619	21618	21617	21616	21605	21592	21584	21576	21568	21560	21552
22127	22126	22125	22124	22123	22122	22121	22120	22119	22118	21551
21626	21625	21624	21615	21604	21591	21583	21575	21567	21559	21551
22108	22109	22110	22111	22112	22113	22114	22115	22116	22117	21550
21631	21630	21623	21614	21603	21590	21582	21574	21566	21558	21550
22107	22106	22105	22104	22103	22102	22101	22100	22099	22098	21549
21634	21629	21622	21613	21602	21589	21581	21573	21565	21557	21549
22088	22089	22090	22091	22092	22093	22094	22095	22096	22097	22749
21633	21628	21621	21612	21601	21588	21580	21572	21564	21556	22749
22087	22086	22085	22084	22083	22082	22081	22080	22079	22078	22749
21632	21627	22760	21611	21600	22757	22755	22753	22751	21555	21547

Figure A-84 Circuit Card 7 Elements and Grid Points





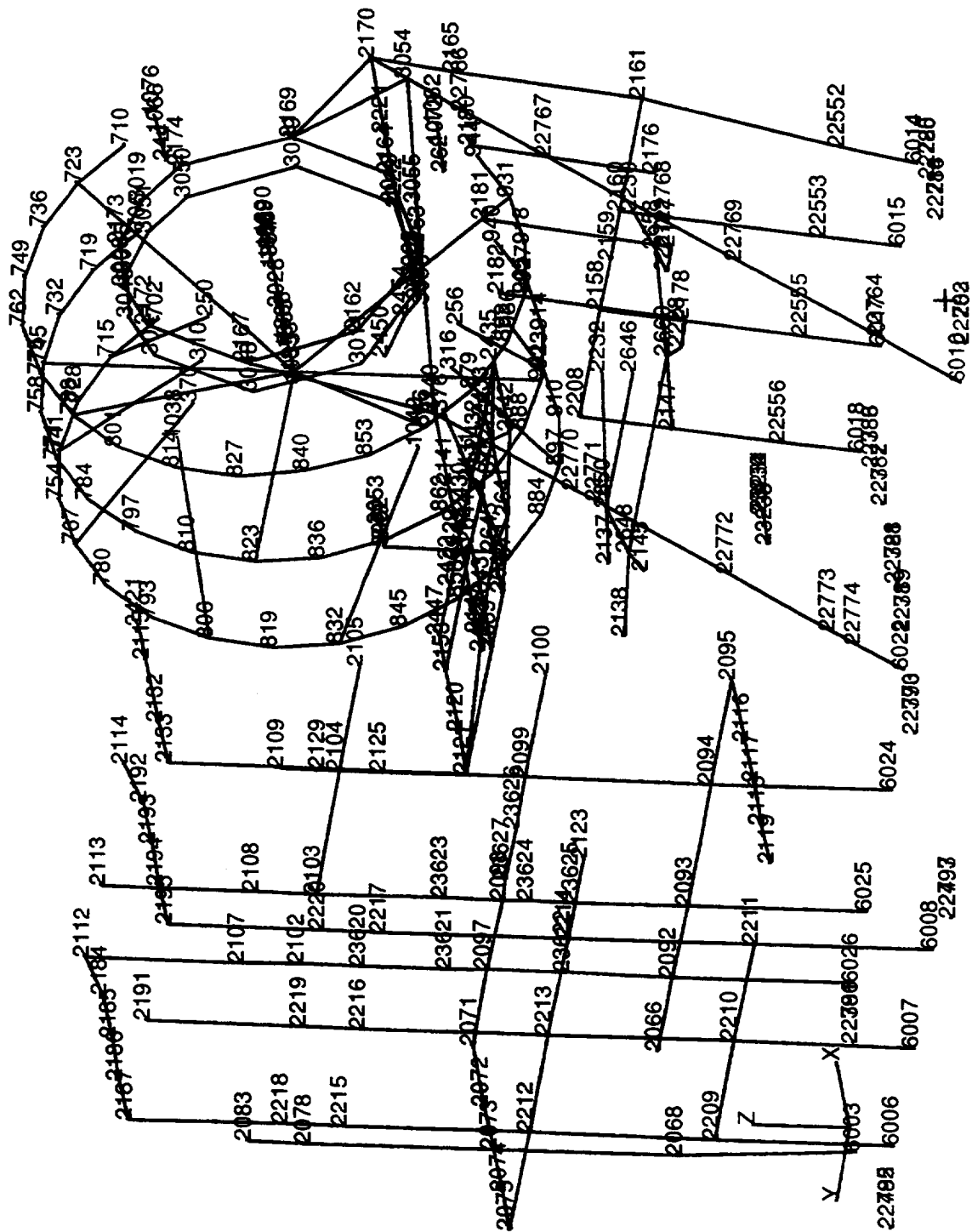


Figure A-87 Model Beam Elements Grid Points



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Report Documentation Page

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6. AUTHOR(S) Wayne Ely				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Aerojet 1100 W. Hollyvale Azusa, CA 91702			8. PERFORMING ORGANIZATION REPORT NUMBER CDRL 102b 10737 November 1995	
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